THE GLASS INDUSTRY

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# INTERFACIAL MICROREACTIONS IN GLASS MELTS

By H. JEBSEN-MARWEDEL

## PART I

### Microscopic Method

Microscopy has rarely been applied to the study of the behavior of glass during the melting process. Relatively simple devices suffice for the microscopic observation of the mechanism of less known melting phenomena.

As a rule, glass melts remain inhomogeneous to the stage of the finished product and may be considered as consisting of special units of variegated shape. In the initial stage of mixing, the process of solution and other chemical reactions are limited to the interfaces. The interfaces thus become the origin and the preferred location of secondary phenomena.

In the case of glass, the optical effects of striae and other inhomogeneities, the formation of bubbles and the segregation of glass gall, have to be considered. These phenomena are shown as starting at the interfaces; that is, in the zone of particularly active molecular mobility. The resulting condition is an essential characteristic of the glass melt since it becomes frozen in the finished product. If the defects of the product are to be traced to their origin, the microscopic exploration of the mechanism of these interfaces becomes imperative.

### Cords and Surface Tension

The role of cords in glass surpasses that of similar inhomogeneities in other fields of technology. Cords have almost become accepted as unavoidable characteristics of glassware. The successful exploration of such inhomogeneities in the study of convection and in ballistics[1] may serve to incite the exploration of glass cords with the double purpose of the elimination of defects and the penetration of essential properties of glass.[2]

The surface tension has been recognized, along with viscosity, as being of major importance in the control of the behavior of separate units in the melts.[3] It is unique in signalizing the action of molecular forces by visible dynamic changes of shape and relocations of matter.

If two liquids mix, they follow the laws of adhesion: the liquid of smaller molecular forces or smaller surface tension will try to coat the neighboring liquid in the form of a thin film.

The initial arrangement will consist of concave elements as shown in Plate I. If a single layer of two kinds of glass spheres is selected in an experimental melt on platinum foil,[4] this arrangement may be readily demonstrated (Plate II). The essential factor in this basic arrangement of a unit of lower surface tension is the increased surface area providing an increased basis of diffusion. This condition may be described by the use of the term "negative surface tension." Regardless of the method of description, the liquidation of the unit can be called the consequence of a difference in molecular forces.

The smaller surface tension of a unit, therefore, is a

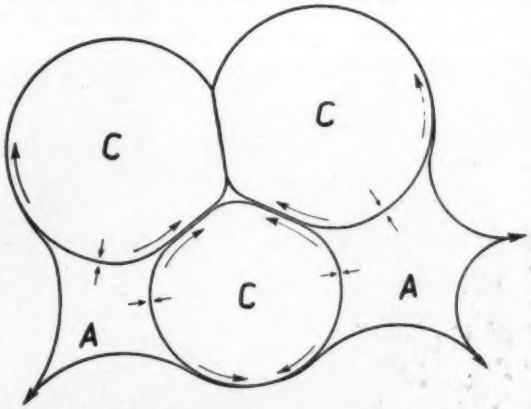


**Fig. 1. Distribution of elements of smaller (A) and larger (C) surface tension. Adhesion prevails over diffusion. Solution is preceded by capillary distribution.**

Fig. 2. No hole: a colorless cord of small surface tension and hypocycloidal shape spreads on the dark environments. The "hole" contracts until it vanishes completely. The liquidation proceeds in the direction of the arrows.

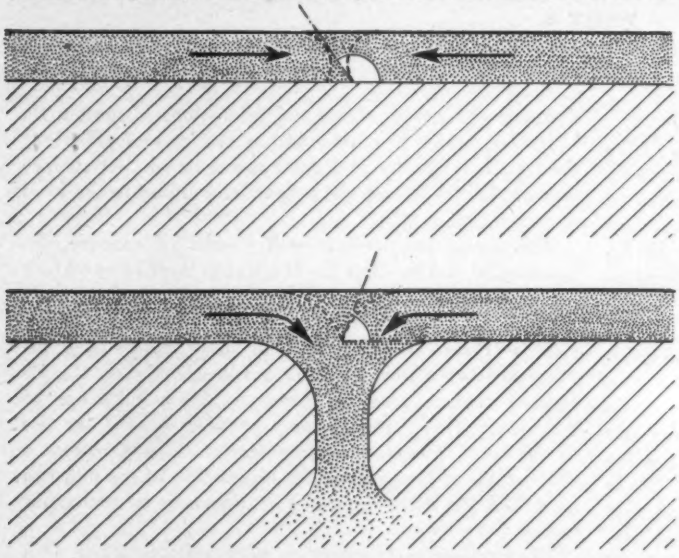


Fig. 3. The adhesion skin of an insoluble liquid (a) forms a coherent layer. In soluble pairs with acute contact angle the skin is deflected, "splits" the bulk and is only dissolved by diffusion from a capillary thread.

Fig. 5. Molecular Hydrodynamics. The substance of a floating drop of small surface tension is carried away laterally and hydrodynamically incorporated through capillary threads. Example: Acetic Acid (colored) in Water, containing 9.3 per cent NaCl to increase specific gravity. Magnif. 1:1.

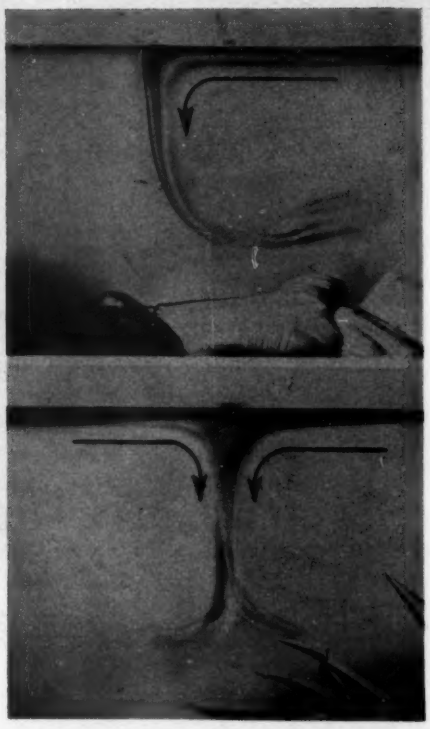

Fig. 4. Glass: The surface layer penetrates the bulk at the head of the wave. When another wave is met, "splitting" occurs. In the lower picture structures of the fracture are observed near the lower edge.

desirable factor in the process of cord elimination.

M. Knight[5] has somewhat discounted the importance of surface tension in the process of homogenization. He doubts that hypocycloidal profiles are the consequence of surface tension and thus questions the importance of molecular forces for the increase of the specific basis of diffusion. His argument is the unrefutable fact that gas bubbles in liquids or oil in water invariably yield spherical enclosures. These two analogies, however, cannot be fully applied to glass since gases do not possess cohesion or surface tension and since no solution takes place in the system water-oil.

### Spread in Soluble and Insoluble Pairs of Liquids

If a liquid of inferior surface tension spreads on a liquid in which it is insoluble, a coherent skin forms exclusively on the surface. This limitation remains true if several zones meet. No other event but a certain orientation of molecules occurs; particularly no diffusion process takes place. This limited process has been termed surface solution[6] (Plate III-a). The result of mixing would be an emulsion.

Fig. 6. (Right) Penetration of the surface (inside of dashed circle) in the form of a capillary current. (Water above acetic acid.)

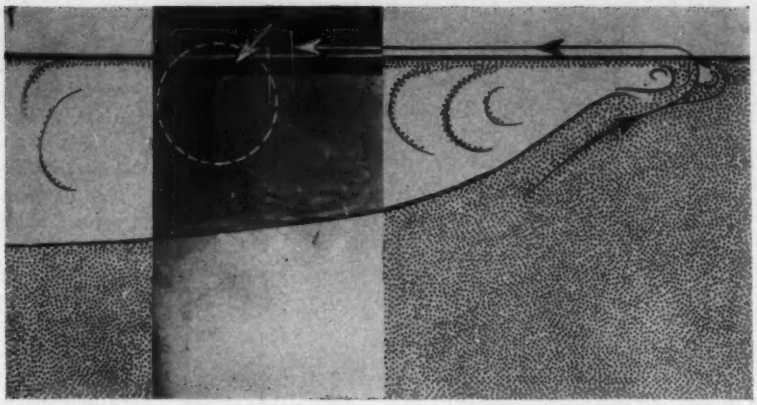

Fig. 7. (Below) Melt of brown glass with three colorless cord centers of inferior surface tension. The centers spread spontaneously, then envelop the entire preparation by a colorless skin which at "seams of impact" and on the rim cause an accumulation of colorless glass. Magnif. 10:1. (Center of picture 20:1.)

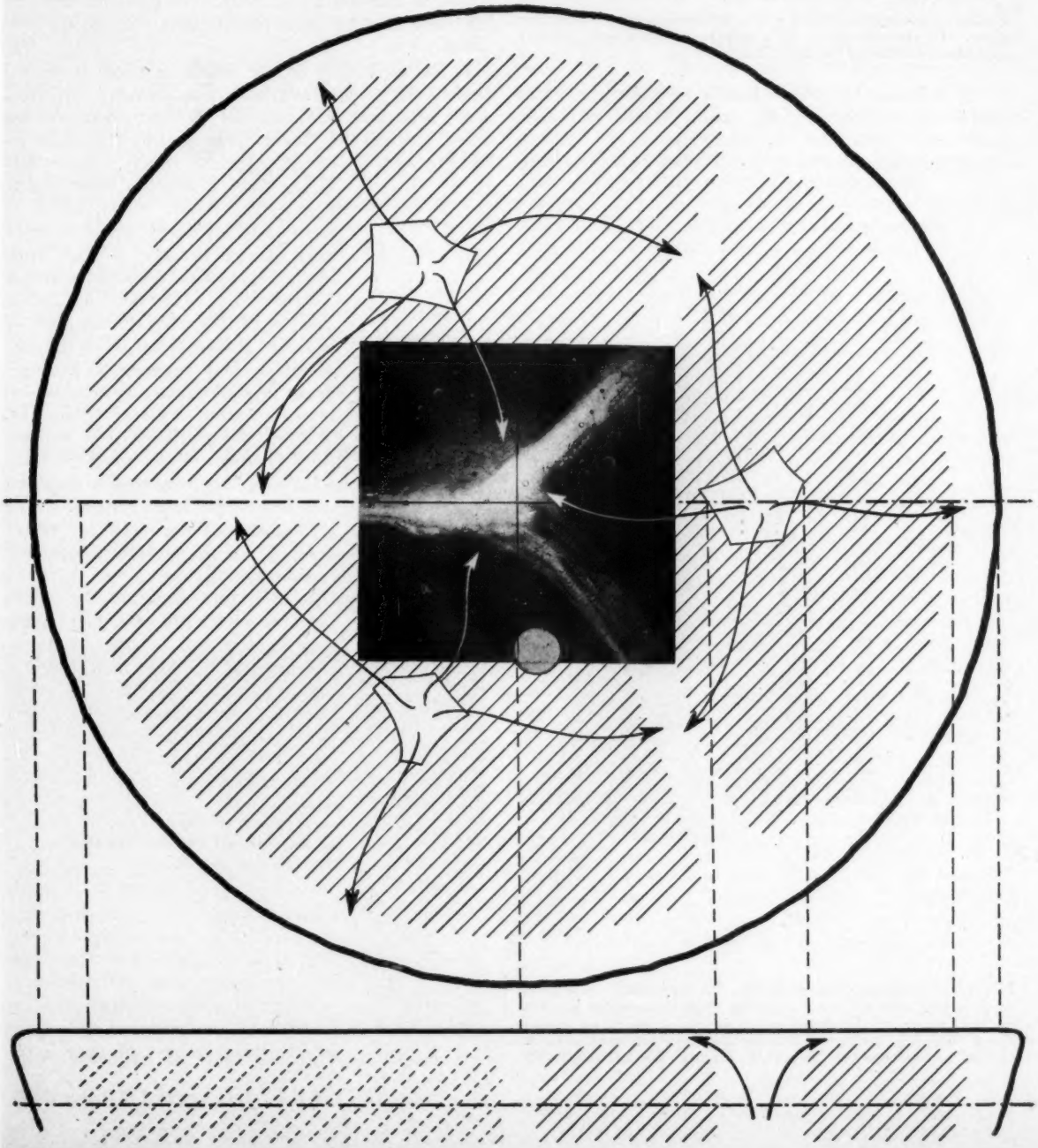

**Fig. 8. Four dark cells of cords introduced into a colorless glass. In the center of their sphere of influence (circle) spontaneous mixing occurs. Magnif. 6:1.**

The behavior of soluble liquids is entirely different even if the solubility is very small. Whenever two or more surface skins meet, they may penetrate the liquid of higher surface tension at the head of the "wave" and are deployed hydrodynamically (Plate III-b).

They are then not restricted to the surface but penetrate the bulk. By the multiple repetition of a microphenomenon they contribute essentially to homogenization especially because of the continuous renewal of the surface of a glass melt by thermal current (Plate IV, see also Plate VIII—ref.[4]).

This phenomenon can be observed in normal liquids. In a narrow vessel glycerole—or, better, acetic acid (s.t. = 23.46 dyn/cm)—is brought in contact with water (s.t. = 72.5 dyn/cm), the specific weight of which had been made equal to that of the other liquid by the addition of sodium chloride. Because of its lower surface tension, the floating drop spreads faster than it diffuses or dissolves.

In contrast to oil, the spreading thin layer penetrates the base. Formation of capillary current threads precedes solution. The threads suck the substance until the supply is exhausted. A lively hydrodynamic effect results and lasts for some time without external support[7] (Plate V).

If the specifically lighter substance water is poured above acetic acid, a remarkable phenomenon is observed. Acetic acid, because of its lower surface tension, does not resign itself to the "lower" position which it might assume because of its higher specific gravity. Acetic acid rather tends to envelop water and to oppose its spread. Water, which in contrast to oil avidly dissolves acetic acid, accepts it into solution from above although the bulk of the acid is located below. The molecular forces cause a suction effect in the form of capillary threads—just as in the case of glass—and promote a hydrodynamic turmoil quite opposite to the expected direction of spread (Plate VI). The process is maintained by molecular forces in a lively manner. Only when water has penetrated to the other end does the pulsation subside.

The work of the molecular forces accounts for the spontaneous mixing ensuing in both cases.

In the normal liquids of this experiment the mixing process is more lively than in glass and is accessible to direct observation. Nevertheless, its existence in glass can be demonstrated.[4] The relative predominance of adhesion over diffusion phenomena is significant and suggests the superior behavior of cullet of lower surface tension.[4, 8]

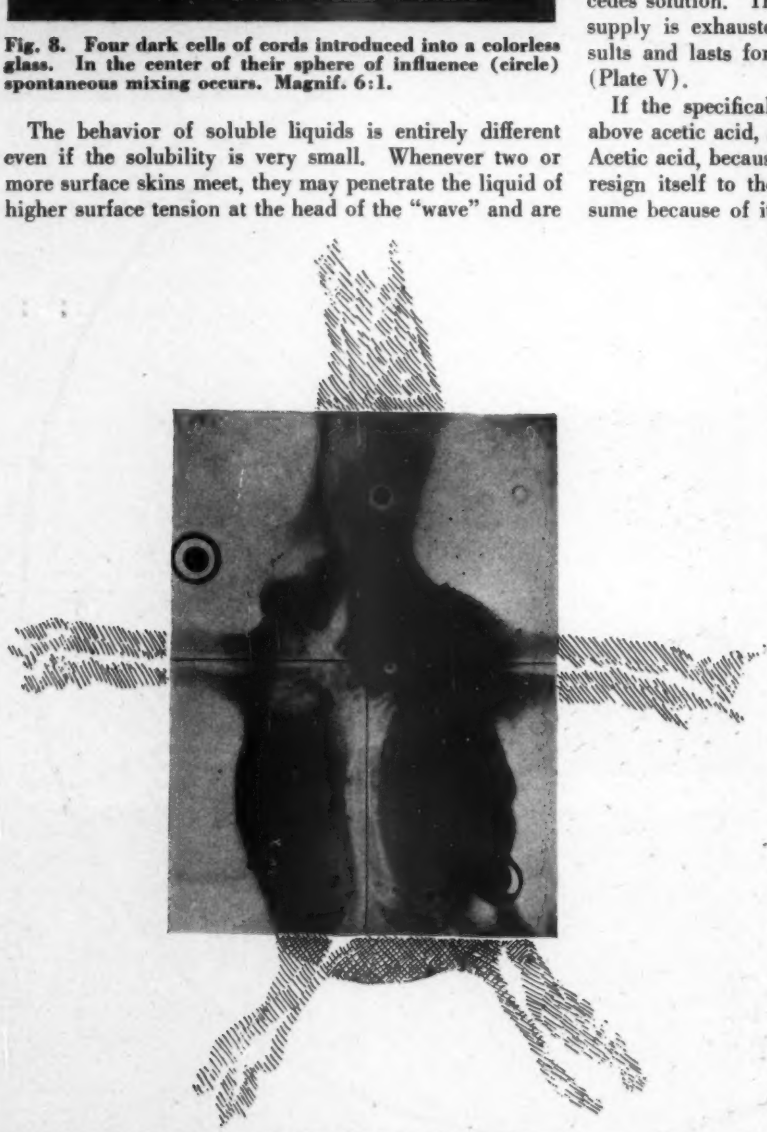

**Fig. 9. (Progressive stage of Fig. 12, left side.) A brown cord center with a surface tension slightly superior to that of the colorless surroundings becomes subject to something like cell *division*. During this process substance is carried away from the "seams." Magnif. 25:1.**

### Transport of Matter on the Surface of the Melt

The role of the surface of the melt in the transportation of spacial units of lower surface tension becomes evident in the preparation of Plate VII. Three colorless centers of striation—originally of spherical shape—were inserted into environments of higher surface tension. Because of their lower

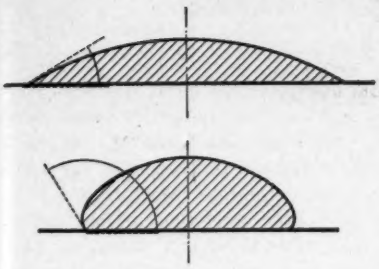

**Fig. 10.** (Left) Drop of glass on neutral base (platinum) in oxidizing (above) and reducing (below) coke furnace atmosphere. The surface tension changes reversibly as much as 22 per cent.

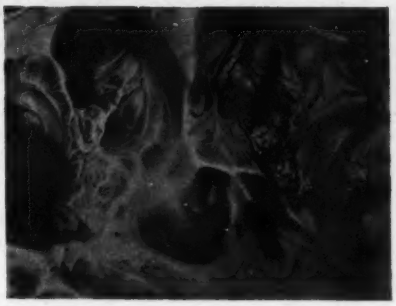

**Fig. 11.** (Right) Reflection of a glass surface originally consisting of equivalent constituent parts in the process of reorganization.

surface tension they spread over the entire melt. Where they meet they again penetrate the bulk of the melt. The penetration is so intensive that the new internal interfaces consist solely of the colorless glass contained in the three original cords. Similarly, the colorless glass concentrates at the edge where no extended area is available for a further spread.

Similar phenomena were observed when four dark cord centers were inserted into a melt (Plate VIII). Large magnifications reveal a vigorous mixing process penetrating the entire preparation, starting from the middle point of the area affected by the four artificial cords. The process is analogous to that observed in the case of glycerole or acetic acid and water. This starting point is far away from the actual sources of inhomogeneity just as acetic acid and water do not mix in the bulk of the drop but from the surface.

If, however, particles of larger surface tension are surrounded by matter of smaller surface tension in the surface of the melt, they split. The partition is reminiscent of the division of cells of low organisms (Plate IX). Patient observation reveals the hydrodynamic transportation of its substance. Only in this case of cords of higher surface tension is the location and the origin of the process identical.

It has been shown that a reducing furnace atmosphere increases the surface tension of glass by about 20 per cent.[8] Therefore, the surface of the melt assumes another important function (Plate X). Because of the increased surface tension the skin of the melt bursts when exposed to reduction and gives access to surging lower layers. This continuous microprocess comprises large masses of glass and contributes essentially to homogenization. The process is discontinued under the influence of oxidizing gases when the layer of lowest surface tension is on the surface and a condition of lowest free energy has been attained.

Plate XI shows the surface of a melt in reflected light during the process of homogenization exhibiting vivid displacements of matter.

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## HARBISON-WALKER IN FULL PRODUCTION IN NEW BALTIMORE PLANT

Although there has been a need for additional facilities for the production of basic refractories for many years, due to wartime restrictions it was not until April 1946 that the new Harbison-Walker Refractories Company plant in Baltimore was completed. Slow deliveries of equipment further retarded initial operation of the plant until November 1947.

**Tunnel kiln, 324 feet long, for firing burned brick.**

The new plant, however, is now in full operation with increasing capacity producing basic refractories. Although the bulk of this production is for the steel industry, among the various types of refractories manufactured, Harbison-Walker also serves the glass industry, producing Forsterite refractories which are used as checker brick in regenerative glass tank furnaces.

The new Baltimore Harbison-Walker plant is the last word in layout, equipment and closely controlled operation. The site of the new plant was chosen because the port of Baltimore offers accessibility for incoming raw materials and adjacent freight yards provide ease of shipping finished refractories to all points. Possible future expansion has also been taken into consideration.

## NORBERT KREIDL NAMED BAUSCH & LOMB DIRECTOR OF CHEMICAL RESEARCH

It has recently been announced by the Bausch & Lomb Optical Company that Norbert J. Kreidl has been appointed Director of Chemical Research. Dr. Kreidl fills the post left open by Frank L. Jones, who has joined the research division of the Koppers Company as Business Manager.

Named to assist Dr. Kreidl is Harold C. Hafner, named Assistant Director, who has been associated with Dr. Kreidl as head of the Glass Research Division of the laboratory.

# THE GLASS GLOSSARY

A glossary of terms current in the glass industry is now ready for publication. This compilation is the result of work covering a period of several years, during which a number of meetings have been held, a great deal of correspondence has passed back and forth, and numerous suggestions have been received from members of the Glass Division. It is intended as a part of an extensive glossary which will cover the language of all the ceramic industries.

The General Committee of the American Ceramic Society entrusted with this work is headed by M. F. Beecher of the Norton Company, Worcester, Mass. Committees have been appointed from each division of the Society. For the Glass Division, the Chairman is H. H. Holscher, Owens-Illinois Glass Company, Toledo. With him are associated J. E. Duncan, Pittsburgh Plate Glass Company, Creighton, Pa.; C. H. Hahner, National Bureau of Standards; H. R. Lillie, Corning Glass Works; A. K. Lyle, Hartford-Empire Company; and S. R. Scholes, New York State College of Ceramics. Mr. Holscher's committee constitutes as well the Committee on Standards of the Glass Division and also Subcommittee I on Nomenclature and Definitions of Committee C-14, A. S. T. M. It should be remarked on behalf of this committee that it has been commended by Mr. Beecher for its painstaking activities and that it is the first to report with a glossary ready for publication.

Wherever the accepted dictionary definitions of words seemed to be adequate for the purpose intended, the words have not been included in the glossary. Other words which have a particular meaning for chemists, but which are used in a somewhat colloquial or specialized sense in the glass factory, have been given the industrial definitions. These remarks may serve to explain why some words do not appear in the glossary, also why it is that some words are given definitions that would appear inaccurate to the chemist. For example, arsenic, which is, strictly speaking, a metallic element, is defined in this glossary as an oxide, because the man in the mixing room refers to the white oxide of arsenic simply as "arsenic."

H. H. Holscher

A list of definitions of technical terms has been submitted for criticism and for letter ballot by members of the Glass Division. After due consideration had been given to the resulting criticisms and revisions had been made accordingly, these definitions were regarded as standard and they have been presented in that status.

It is practically impossible to write a definition, particularly of a technical term, that will satisfy everyone. The committee found it necessary to make numerous compromises in finally reaching the most satisfactory definition for each term, having in mind the concept itself and the language in which it must be set forth. A few definitions could be written quite readily in a form that would satisfy each member of the committee; others became subjects of lengthy debate, which generally brought out acceptable phrasing.

It will be remarked that each member of the committee is more familiar with some certain branch of glass technology than are the others: Mr. Holscher, containers; Mr. Duncan, flat glass; Mr. Hahner, optical glass; Mr. Lillie, glass physics; Mr. Lyle, glass containers and glass-forming machinery; Mr. Scholes, tableware and furnaces. Ordinarily, but not always, other members of the committee deferred to the one most conversant with usage in his particular field.

This glossary must be regarded by any reader familiar with glass manufacture as incomplete. From time to time, other terms must be added and defined. Locally, in single factories, some expressions are in use that had not come to the attention of the committee when the list of words was assembled. However, it is believed that the list is fairly complete insofar as terms in general use in American glass factories are concerned.

As a result of this compilation, the strictly technical terms should be more clearly understood and more accurately used by glass technologists, and men in the separate plants should be able to speak the same language. A few words may seem at first reading to be nothing more than the slang or jargon of the glass factories. Nevertheless, it is from slang and jargon

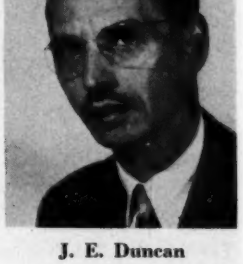
(*Continued on page* 594)

S. R. Scholes

C. H. Hahner

H. R. Lillie

A. K. Lyle



J. E. Duncan

# BORIC OXIDE – ITS CHEMISTRY AND ROLE IN GLASS TECHNOLOGY

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PART VIII

## VII. Boric Oxide as a Minor Constituent of Glasses

*1. The Problem.* In previous chapters glasses were discussed which contained boric oxide as a major and essential constituent for bringing out unusual properties such as high chemical resistivity, resistance to thermal shock, high X-ray transmission, etc. It is the object of this section to describe the role of minor additions of borates to glasses which ordinarily do not contain boric oxide as a characteristic constituent, namely, container glasses, flat glass and table ware.

The use of boric acid or borax as a minor addition to glasses with the aim to decrease devitrification or to improve meltability, appearance or chemical resistance cannot any more be treated rigorously on the basis of the physical chemistry of glass but is influenced by economic factors and as such it is subject to fluctuations. For this reason in the introduction of this treatise a picture was presented of the trends in borax production and the price development. In order to properly judge the role of boric oxide as a minor constituent of glasses a number of factors must be considered.

First among these factors ranks the availability of the raw material and its cost. In this respect the American glass industry is particularly fortunate as there are large resources which are constantly being developed. This factor is important for the understanding of present trends in the glass industry of different countries. The efforts made by the glass industry in Germany to find substitutes for borax are the result of its scarcity. On the other hand, the fact that the European glass industry used borax extensively for improving table ware and even flat glass in spite of its being imported emphasizes its value as a minor constituent.

Other factors which cannot be ignored when evaluating the role of borax as a minor constituent are the quality and cost of refractories, and the cost and availability of fuels. These conditions do not only change constantly and are different for different countries but vary even from one glass plant to another. Many plants are now facing the problem of changing from natural gas to oil vapors, propane or anthracite gas. The problem of fuel for the glass industry is becoming more and more important and obviously the cost of fuel determines whether or not the addition of borax to the glass batch for lowering the melting temperatures and melting time is profitable or not. From the viewpoint of heat economy, glass melting is a rather inefficient process, but the heat economy is limited through the refractory material which is available at reasonable cost. We cannot expect much improvement in the refractories available to the average glass industry. Only if far superior refractories were developed would it be possible to use a better insulation for the melting furnaces which in turn would reflect on the fuel efficiency. Taking all these factors into consideration one can readily understand the reasons why the use of borax more than any other modification in batch composition becomes an individual problem for each glass plant. One may expect that in the future the American glass industry will make more use of borax than in the past because savings in fuel become more important. In principle the beneficial effects which small additions of borax have on the tendency to devitrification of chemical resistivity and on the thermal expansion of soda-lime glasses could also be achieved by other changes in glass composition, e.g., increasing alumina, reducing alkali, etc. These changes, however, would require higher melting temperature, prolonged melting times and consequently increased cost so far as refractories and fuels are concerned.

Borax has been used successfully for lowering the melting temperatures and speeding up fining of the glass. We have seen that boric oxide is a characteristic constituent of several types of heat shock resistant and chemically resistant glasses. On the basis of these beneficial actions of boric oxide some exaggerated statements have been made according to which addition of a little borax is claimed to be a universal patent medicine. Whereas each one of the beneficial actions be obtained, by the proper use of borax, it is not possible to obtain all of them by its addition to the batch in amounts which are economically feasible. It is important to realize that the replacement of a part of the alkali by $B_2O_3$ improves both the chemical resistivity and the resistance to thermal shock, but that such a change in batch composition cannot materially shorten the melting time. However, if a glass performs satisfactorily its melting rate can be increased or the fining temperature can be lowered by introducing boric oxide and decreasing alumina and silica. Obviously such a change will not improve the resistance to thermal shock. These statements seem to be obvious, but nevertheless the lack of understanding of these simple facts has been a source of controversy concerning the usefulness of boric oxide in the glass industry. Another controversy concerning boric oxide arises from the fact that the qualities one wants to improve are not well defined and in most cases cannot be accurately expressed in figures.

J. Enss, for example, pointed out that zinc oxide is superior to boric oxide as a means of improving the chemical resistivity of a glass without sacrificing its

melting properties. He arrived at this conclusion from the behavior of several glasses containing boric oxide and zinc oxide when exposed in a humidity chamber. Under his conditions glasses containing boric oxide replacing silica and alkali behave only slightly better than the blank. Zinc oxide replacing alkali and silica causes a strong improvement of the weather-resistance of the glass. However, through recent work in the National Bureau of Standards (D. Hubbard, 1946) it is known that testing a glass in a humidity chamber gives results which are principally different from those obtained by other methods. In service window glass is exposed to liquid water and not only to water vapor. Consequently the test applied by Enss does not correspond to the actual conditions. The chemical resistivity of window glass becomes an important factor only when the ware is stored under humid conditions, especially when exposed to temperature fluctuations leading to the condensation of moisture. It is this condensed water which attacks the pane by leaching out alkali. Its reaction with the glass surface starts a vicious circle; the more alkali is leached out the more water is attracted from the atmosphere and the more corrosive becomes the liquid.

Before the war the German flat glass industry found it necessary to incorporate boric oxide into window glass which was to be exported to South American countries because during transport the ware was exposed to conditions described above. For those borderline cases where a property has reached a certain critical value which calls for a minor improvement in order to make sure that the ware stands up in service it becomes imperative to use testing methods which actually correspond to service conditions.

*2. Borax Increases Melting Rate.* It is practically impossible to test the melting rate of a glass batch or the time necessary to produce a seed-free glass by laboratory experiments alone. Much of the reliable information concerning the use of boric oxide for speeding up glass melting comes, therefore, from observation in the industry. For this reason several of the papers dealing with this subject are published anonymously. It is significant that the number of publications on the use of boric oxide as a minor batch ingredient increased around 1930, that is, during a period where the price of borax had decreased considerably.

In 1929 W. E. S. Turner reports on large scale experiments carried out in the United States, where manufacturers just began to try out the effect of boric oxide on the melting rate. "In one instance a tank furnace with a maximum output of 60 tons per day prior to the introduction of borax now delivers in excess of 80 tons. In another factory a small tank yielding previously 19 tons as a maximum had its daily maximum raised to 27 tons."

The manufacturers stressed the greater freedom from seeds when borax was used. An anonymous German publication (1932) gives a diagram showing the temperature distribution down a sheet glass tank indicating that the addition of 2% boric oxide made it possible to lower the temperature from 10° to 20°C. In this paper the writer also claims less devitrification and cordiness and a more brilliant glass. The literature on this subject must be accepted with some caution, because manufacturers of "fluxes" containing boric oxide as a major active ingredient advertise the usefulness of their particular product.

The mechanism of batch reactions containing boric oxide as a constituent was studied by M. A. Besborodow and his collaborators. The most extensive laboratory investigation concerning the usefulness of boric oxide as a minor constituent of the glass batch was carried out by W. E. S. Turner and his associates. The first of two investigations (1929) deals with the addition of boric oxide to two representative container glasses used for automatic glass forming machines. Two groups of glasses with increasing $B_2O_3$ content were examined, one containing approximately 0.5% $Al_2O_3$, the other approximately 2.0% $Al_2O_3$.

The batches were melted in small fireclay crucibles of about 2 lbs. capacity. The temperature was 1400°C in one furnace and 1380°C in another. Each of the furnaces contained three crucibles and in order to link up the temperature conditions in the two the 1380°C furnace contained a crucible in each instance charged with the same batch as used for the third glass in the 1400°C furnace. Samples were drawn from the pots at appropriate intervals after the introduction of the final charge. From the appearance of these samples a determination was made of the approximate time needed for the batch to melt completely down.

These experiments indicated a very considerable acceleration of the melting as the proportion of boric oxide was increased. Turner and his associates emphasize that the same effect (for example, the addition of 1% $B_2O_3$ decreases the melting time 20-30%) cannot be expected in a large furnace. Nevertheless, the results seemed so striking that no doubt could be left about the beneficial action of boric oxide on the rate of glass melting. They also found a distinct improvement in the fining rate and in the elimination of seeds.

The discussion of this paper in a meeting of the British Society of Glass Technology brings out another beneficial action of boric oxide. As a result of the accelerated melting less selenium is lost and it was the general opinion that less selenium was needed for decolorizing the glass after the introduction of borax.

Another interesting contribution to the problem was made in the same discussion by F. G. Clark. His company had started to use borax 3-4 weeks before in a small tank. He found that the surface of the glass was very much improved. The brilliance was greater, the color was better and it seemed that the addition of borax in the proportion of 50 lbs. to 1,000 lbs. of sand was very beneficial. He also mentioned that the temperatures of this tank could be lowered 20-30°C without impairing in any way the fining of the glass.

The lively discussion of Turner's paper on the use of boric oxide in container glasses and the experience of glass melters in the U.S.A. brought to light that in England some manufacturers of bottles had used boric oxide as a minor constituent (i.e., 18 lbs. of borax to 1,000 lbs. of sand) for many years. Some of them, however, had anxiously guarded their secret from competitors.

A few years later W. E. S. Turner and his colleagues (1934) extended their investigation to soda-lime-magnesia glasses of the window glass type. Up to a maximum of 1.5% $B_2O_3$ was introduced into some fifty different glasses. The experiments brought out that these glasses also could be melted and fined much faster if

$B_2O_3$ was added. The chemical resistivity was only slightly improved and the thermal expansion was reduced. The procedure was the same as in their previous work on container glass compositions.

There can be no doubt that the role of boric acid on the rate of melting and fining is largely one of lowering the high temperature viscosity of the glass. However, the possible influence of $B_2O_3$ on the surface tension should not be overlooked. Another point which deserves mentioning is the fact that $B_2O_3$ introduces into the glass-melt a considerable quantity of water which aids fining. This feature distinguishes $B_2O_3$ from other fluxes such as BaO and $CaF_2$, which also lower the viscosity of a glass and accelerate the melting process. In a previous chapter it has been pointed out that boron has the ability of retaining in the form of B-OH groups some of the water present in the glass batch up to relatively high temperatures.

It seems immaterial in which form the boric oxide is introduced. Boric acid, hydrated borax and other boron minerals have identical effect. An extensive study of F. H. Zschacke and J. Vartanian, comparing $H_3BO_3$ with hydrated borax, seems to confirm these observations of glass melters.

As compared with other fluxes, especially fluorine and barium, boric oxide offers the advantage of being less corrosive on the refractory, so that it can be introduced in relatively large quantities. The use of barium and fluorine is impaired by their stronger action upon the refractory.

*3. Boric Oxide Improves Chemical Resistivity.* In an earlier section of this paper it was explained how boric oxide as a water soluble substance can improve the resistance of an alkali silicate to water or diluted acids. The work of W. E. S. Turner and his associates brings out this beneficial effect of $B_2O_3$ as a minor constituent. Its magnitude depends greatly on the glass composition. It is negligible in resistant glasses, for example, if the glass contains approximately 2% alumina but becomes very significant for glasses of poorer chemical resistance.

Recently the General Research Laboratory of the Owens-Illinois Glass Company published a valuable contribution on the influence which $B_2O_3$ exerts upon the chemical resistivity of soda-dolomitic lime-silica glasses. In one of a series of publications dealing with the effect of minor constituents on glass properties boric oxide is examined as a substitute for (a) $SiO_2$, (b) $CaO \cdot MgO$ and (c) $Na_2O$.

The replacement of up to about 3% $SiO_2$ by $B_2O_3$ in a 10% dolomitic lime glass increases its resistance to dilute acids. Further substitution of $B_2O_3$ for $SiO_2$ gives no appreciable improvement. In the case of a 12% dolomitic lime glass no benefits could be derived for the chemical resistivity from replacing $SiO_2$ by $B_2O_3$.

The replacement of $CaO \cdot MgO$ by $B_2O_3$ improves the resistance of the 10% and 12% dolomitic lime glasses, proportional to the amount of $B_2O_3$ introduced.

The most striking improvements of the acid resistivity could be achieved if the alkali was partly replaced by $B_2O_3$. Up to 3% $B_2O_3$ produces the strongest effects.

In respect to its resistance to distilled water the replacement of alkali by $B_2O_3$ improves the glass throughout the range examined. As a substitute for $CaO \cdot MgO$ this beneficial effect becomes noticeable only if 3% $B_2O_3$ or more are added. As a substitute for $SiO_2$ boric oxide does not improve the resistance to water.

From all these measurements we may learn, that boric oxide in minor concentrations provides an excellent means for improving the chemical resistivity of a glass without impairng its melting rate or fining properties.

*4. Boric Oxide as a Means to Prevent Devitrification.* For a glass having a tendency to devitrify during working the addition of boric oxide is generally considered a sure remedy. This effect of boric oxide, namely, preventing the crystallization of glasses, is not yet completely understood. Like in most chemical processes we understand the thermodynamic part fairly well, but the kinetics of the reactions are still in the dark. We know from several investigations how $B_2O_3$ affects the phase equilibria but we cannot readily explain why it slows down the rate of devitrification. The theoretical aspects have been discussed in an earlier chapter on the "Structural Aspects of $B_2O_3$ Containing Glasses."

G. W. Morey investigated the effect of $B_2O_3$ on the liquidus temperature of soda-lime-silica glasses. $B_2O_3$, up to 5%, was added to 21 glasses in or near the stability field of devitrite, that is, the commercially interesting part of the ternary system $Na_2O$-CaO-$SiO_2$. In all cases boric oxide was found to lower the liquidus temperature. The liquidus temperature is the lowest temperature at which a glass melt may be kept without the occurrence of devitrification. This temperature above which it is safe to keep a glass does not give us the complete story of devitrification. What we want to know is the rate of crystal formation below the liquidus temperature. No doubt the viscosity in this temperature region gives us some valuable hints. There are other factors influencing the devitrification, namely, deviations from the equilibria conditions which are represented in the quarternary diagram $Na_2O$-CaO-$SiO_2$-$B_2O_3$ (G. W. Morey). It is quite common that on its way to the equilibrium a reaction product of intermediate stability is formed (Ostwald's Law of Stages). Another deviation from the results to be expected from equilibria consideration comes from the change of composition of the surface layer through partial volatilization of alkali.

The facts that $B_2O_3$ resisted all attempt to obtain it in crystalline form for so long (1937) and that the only convenient method of obtaining crystallized $B_2O_3$ is based on a round-about way, using a certain modification of $HBO_2$ as a seed cannot be explained on the basis of liquidus temperature and viscosity alone. The systematic work of the Owens-Illinois Research Laboratory will be most useful for understanding the influence of minor additions of $B_2O_3$, because it reveals their influence on the liquidus temperatures and on the viscosities of the glasses. Furthermore, this series of publications permits us to draw comparisons between the effect of $B_2O_3$ with that of other minor constituents such as fluorine, phosphorus pentoxide, barium oxide and zinc oxide.

Summarizing the role of minor additions of boric oxide to glasses of the soda-lime-silica type we may say that its beneficial action upon the melting and fining rate of glasses is by far the most outstanding feature. Improvement of the appearance of the ware seems to be beyond any doubt. The use of boric oxide in its various forms and the quantity which should be introduced into the batch depends on a great variety of factors. The

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# OPTICAL GLASS AT THE NATIONAL BUREAU OF STANDARDS

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Department of Commerce, Bureau of Standards

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Optical glass is a critical war material that is produced only in small quantities in peacetimes. But even then its importance is out of proportion to its size. This small industry furnishes the material for many types of instruments that are the eyes of science and of technology. In times of war, not only does this industry expand greatly, but superimposed on this increased expansion is the military demand. During the recent war, a large proportion of our population was introduced to this type of glass for the first time, and used and repaired many instruments containing elements made of it. Much was heard of gunsights, binoculars, aerial cameras, range finders, telescopes, interferometers, periscopes and some instruments that were unheard of before the war.

Prior to World War II, the Bausch & Lomb Optical Co. and the National Bureau of Standards were the only producers of optical glass in the United States. Others started production during the war to supply the expanded needs of the armed services.

The National Bureau of Standards expanded its production of optical glass from 8,000 pounds in 1938 to 236,000 pounds in 1943 and increased the number of types of glass produced from 5 to 28. The glass is melted in single-pot, regenerative type furnaces. The finished glass is cooled in the pot, inspected for defects, broken into pieces and molded into various sized blanks. After a final inspection, the blanks are annealed to stabilize the glass and are then ready for grinding and polishing.

The quality of the glass and the appearance of the blanks steadily improved during the war until there is now no better glass produced.

As a result of the lessons learned during World Wars I and II, the United States can in any future emergency produce an ample supply of optical glass of high quality. Continued research is necessary to develop the optical glasses required for new and improved military instruments.

**Fig. 1. An optical glass pot and stirring thimble in a pot arch preparatory to burning.**

## I. Optical Glass in the U. S. A.

The production of optical glass in the United States is a modern industry. As nearly as can be determined, the first optical glass was successfully produced about 1893 by MacBeth and Company of Pittsburgh, Pa.[1] Beginning in 1896, and continuing for approximately six years[2], the Manhattan Optical Company operated a small glass plant at Cresskill, N. J. This company then combined with the Gundlach Manufacturing Company of Fairport, N. Y., and ceased operation. In 1912 the Bausch and Lomb Optical Company of Rochester, N. Y., started production that has continued to the present day.

The National Bureau of Standards entered the optical glass field in July, 1914, at its Pittsburgh laboratory then under the direction of P. H. Bates. To indicate its growth, Table 1 gives the annual production of optical glass at the Bureau for a number of years within a 27 year period.

TABLE 1.

THE PRODUCTION OF OPTICAL GLASS AT THE NATIONAL BUREAU OF STANDARDS[1]

| Year[2] (Fiscal) | Pounds of glass delivered | Year (Fiscal) | Pounds of glass delivered |
|---|---|---|---|
| 1921 | 1145 | 1941 | 36,785 |
| 1923 | 2200 | 1942 | 136,550 |
| 1931 | 3001 | 1943 | 236,558 |
| 1934 | 5552 | 1944 | 230,012 |
| 1937 | 7530 | 1945 | 195,777 |
| 1939 | 8422 | 1946 | 57,495 |
| 1940 | 7297 | 1947 | 16,040 |

[1]Shipments of optical glass of good quality started in November, 1917, and continued from then on, being 3021 pounds for October, 1918. (Report of the Secretary of Commerce to the President for 1919).
[2]Selected years are given merely to indicate trend of production.

Four additional manufacturers produced optical glass during World War II because of the unusual demand.

## II. The Production of Optical Glass

Optical glass is divided into three general types: 1) transfer, 2) rolled and 3) ophthalmic. This paper will

deal only with transfer glass since that is the type produced at the Bureau. Transfer glass is processed by three methods, namely, 1) "stick up" or "punty," 2) paddling and 3) slumping.

*1. Properties of optical glass.* The most important requirement for glass of optical quality, and one that is extremely difficult to meet, is that the glass in each lens or prism element be of uniform quality throughout, and that its optical constants agree closely with those of the standard type glass for which the element was designed. To manufacture on a large scale a series of different glasses to this degree of perfection requires close attention to detail.

Wright[3] has made an excellent list of the properties of good optical glass. They are: *I. Homogeneity.* 1. Uniformity of chemical composition. a) Freedom from striae. b) Freedom from bubbles. c) Freedom from inclusions, stones and crystallites. d) Freedom from cloudiness. 2. Uniformity in physical state. a) Freedom from strains. *II. Definite refractive indices for different wavelengths.* 1. Refractivity. 2. Dispersivity and dispersion ratios. *III. Freedom from color. IV. High degree of transparency. V. High degree of chemical and physical stability.* 1. Resistance to action of weather and certain chemical agents. 2. Toughness and hardness.

*2. Pots.* Optical glass is made at the National Bureau of Standards in clay pots, of approximately seven cubic feet capacity, which are used only once. Pots may fail due to attack of the glass on the pot body or from cracking induced by thermal shock. One of the principal compromises in optical glass production is the selection of the most suitable pot body. The denser or less porous a pot is, the less it is attacked by the molten glass or batch materials, but the denser the pot, the more sensitive it is to thermal shock. Any particular body is, therefore, somewhat less than the ideal both as to corrosion resistance and resistance to thermal shock. All of the optical glasses except Borosilicate Crown 517/645 are melted in pots containing a lining of low porosity. This lining is sprayed with an additional thin coating of slip to seal incipient, invisible cracks. In this way, a pot is obtained with an inner layer of low porosity material in contact with the glass but with the greater part of the pot having a relatively high porosity which will resist thermal shock. These pots and the clay thimbles used for stirring are described in a recent paper by Heindl, Massengale and Cossette[4].

Dried pots are burned in pot arches immediately before use and are transferred while hot to the melting furnace. Figure 1 shows a pot and stirring thimble in the arch. The pot is moved from the arch to the melting furnace by a carriage equipped with a pair of tongs to hold the pot. These tongs are controlled from the rear end of the carriage as is also a counterweight that can be moved along the carriage to balance the weight of the empty pot or of one filled with glass. Each pot arch is heated by gas from the rear by three low pressure air burners which make use of a premixture of gas and air. The flame is deflected upwards by means of a brick wall immediately in back of the pot and the products of combustion are exhausted through flues in the floor. The burning requires from 53 to 109 hours, depending on the type of the pot body, the longer schedule applying to the body of lowest porosity. Burning schedules for the two types of pots are given in Figure 2.

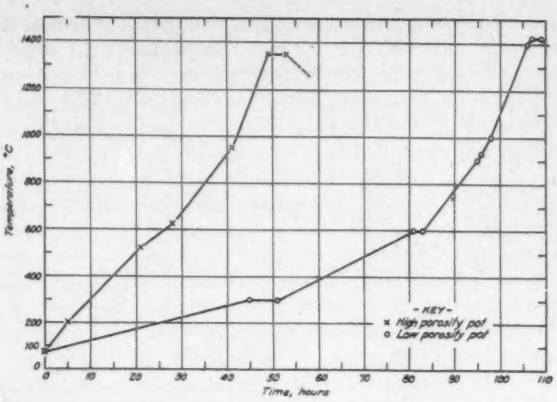


**Fig. 2. Burning schedules for pots used at the National Bureau of Standards.**

*3. Batch materials and batch composition.* Batch materials of the highest commercial purity are necessary as ingredients for the production of optical glass. Since decolorizing agents cannot be used, the amounts of coloring oxides in the materials must be limited to traces, especially in those making up the larger portions of the batch. The specifications for some of the batch materials are given in Table 2. Batch materials should be of approximately uniform grain size so that they will mix easily with each other and, when incorporated in a batch, will not segregate.

Each barrel of potash is checked for its alkalinity, calculated as $K_2CO_3$, prior to use. Materials such as soda ash and borax, the moisture content of which varies with storage, are mixed in 2,000-pound lots and analyzed for their $Na_2CO_3$ and borax ($Na_2B_4O_7.10H_2O$) content shortly before use.

A scale with a printweigh attachment, that makes a permanent record of the weights of the materials added, is used for weighing. The batch is transferred from the scale to a concrete type mixer, or to a drum type mixer, and mixed for 15 to 20 minutes. From the mixer the batch is dumped into a cart for use by the melting crew.

Table 3 gives batch compositions on the basis of 100 per cent purity. However, the materials used are not 100 per cent pure; consequently the weights must be adjusted for variations in composition as determined by chemical analysis.

*4. Melting.* The melting furnaces are of the single-pot, regenerative type. There are three burners on each side of the furnace. Bag walls, extending slightly above the top of the pot, separate the melting compartment from the regenerator ports and direct the flames toward the crown. Direction of flow of the gases is reversed at half hour intervals. The siege on which the pot rests is leveled with anthracite breeze or ash immediately before setting the pot in the melting furnace.

The filling of the pot is accomplished by means of a long-handled scoop. When the furnace temperature reaches 1250° C (thermocouple reading), 100 to 150 pounds of cullet are charged into the pot. The furnace is brought up to the melting temperature (1350°-1450° C, depending on the type of glass) within one-half to one hour, after which the pot is filled three-quarters full of batch. One hour later the pot is filled with batch and additional fillings are made every half hour thereafter until the pot is full of glass. The time required to fill

TABLE 2. SPECIFICATIONS FOR BATCH MATERIALS USED IN THE PRODU OPTICA

| Constituent | Batch Materials[1] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sand | Flint, powdered | Boric Acid, Borax, Saltpeter, Sodium Nitrate and Potash (83-85%) | Soda Ash | Litharge | Barium Carbonate and Hydrate | Zinc Oxide | Potash (99%) | Calcium Carbonate | Barium Nitrate | Li tium Carbonate T |
| | % | % | % | % | % | % | % | % | % | % | % |
| $Fe_2O_3$[2] | < 0.02 | < 0.025 | < 0.002 | < 0.003 | < 0.005 | < 0.005 | < 0.005 | < 0.0025 | < 0.010 | < 0.005 | < 0.030 < |
| Cl | — | — | < 0.10 | < 0.25 | < 0.10 | < 0.10 | — | < 0.125 | < 0.10 | < 0.10 | < — |
| $SO_3$ | — | — | < 0.10 | < 0.10 | < 0.10 | < 0.25 | < 0.35 | < 0.125 | — | < 0.10 | < — |
| $SiO_2$ | > 99.25 | > 99.0 | — | — | — | — | — | — | — | — | — |
| $Al_2O_3$ | < 0.20 | < 0.25 | — | — | — | — | — | — | — | — | — |
| $CuO_2$ | — | — | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 < |
| $Cr_2O_3$[2] | — | — | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 < |
| $MnO^2$ | — | — | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 < |
| $CoO^2$ | — | — | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 < |
| $NiO^2$ | — | — | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 < |
| MgO | — | — | — | — | — | — | — | — | < 0.50 | — | — |
| $CaCO_3$ | — | — | — | — | — | — | — | — | — | — | < — |
| $K_2CO_3$ $Na_2CO_3$ | — | — | — | — | — | — | — | — | — | — | < — |
| $TiO_2$ | — | — | — | — | — | — | — | — | — | — | — > |
| BeO | — | — | — | — | — | — | — | — | — | — | — |
| $ZrO_2$ | — | — | — | — | — | — | — | — | — | — | — |
| BaO, CaO and MgO | — | — | — | — | — | — | — | — | — | — | LO |

[1] Materials of the specified purity are readily available.
[2] Coloring oxides.

TABLE 3. BATCH COMPO FOR OF

TYPE OF GLASS[2] (*Weight of Ingredients Requir*

| Batch material | Calculated as: | BSC 511/635 | BSC 517/645 | BSC 536/644 | LC 512/605 | LC 523/586 | LC 528/580 | BaC 541/599 | BaC 574/577 | BaC 611/588 | Ba 617/ | BF 584/4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | [3] | | [3] |
| Sand or powdered flint | $SiO_2$ | 670.8 | 530.4 | 760.9 | 701.0 | 744.1 | 812.8 | 602.7 | 506.2 | 429.0 | 46 | 656 |
| Litharge | PbO | — | — | — | — | — | — | — | — | 2.2 | 1 | 247 |
| Barium Carbonate | $BaCO_3$ | — | — | — | — | — | — | 262.5 | 331.1 | 272.7 | 54 | 226 |
| Boric Acid | $B(OH)_3$ | — | 62.1 | 277.0 | — | 28.2 | 31.7 | — | 60.8 | 212.9 | 9 | — |
| Borax | $Na_2B_4O_7 \cdot 10H_2O$ | 227.0 | 178.2 | — | 133.5 | — | — | 95.4 | 96.5 | — | — | — |
| Soda Ash | $Na_2CO_3$ | 67.0 | 53.1 | — | 207.9 | 232.4 | 260.9 | 29.6 | — | — | | 35 |
| Saltpeter | $KNO_3$ | 65.0 | 59.0 | 69.9 | 45.4 | 56.9 | 63.9 | 50.0 | 48.7 | — | 1 | 173 |
| Zinc Oxide | ZnO | — | 9.6 | — | — | — | — | 42.0 | 84.0 | — | 7 | 103 |
| Arsenic Oxide | $As_2O_3$ | 2.0 | 4.0 | 5.0 | — | — | — | 3.1 | 3.4 | 4.5 | | |
| Antimony Oxide | $Sb_2O_3$ | — | — | — | 11.7 | 12.7 | 14.3 | — | 7.8 | 2.2 | | — |
| Potash | $K_2CO_3$ | 165.9 | 100.6 | 61.3 | 40.5 | — | — | 120.7 | 81.8 | — | — | 4 |
| Beryllia | BeO | — | — | 24.0 | — | — | — | — | — | — | | — |
| Strontium Carbonate | $SrCO_3$ | — | — | 170.8 | — | — | — | — | — | — | — | — |
| Lithium Carbonate | $Li_2CO_3$ | — | — | 148.5 | — | — | — | — | — | — | — | — |
| Calcium Carbonate | $CaCO_3$ | — | — | — | 38.3 | 177.8 | 240.0 | — | — | 89.9 | | — |
| Salt | NaCl | — | — | — | — | 15.8 | 17.7 | — | — | — | — | — |
| Salt Cake | $Na_2SO_4$ | — | — | — | — | 9.4 | 10.6 | — | — | — | — | — |
| Alumina | $Al_2O_3$ | — | — | — | — | — | — | — | 33.6 | 32.5 | 6 | — |
| Barium Hydrate | $Ba(OH)_2 \cdot 8H_2O$ | — | — | — | — | — | — | — | 131.8 | 436.0 | 162 | — |
| Barium Nitrate | $Ba(NO_3)_2$ | — | — | — | — | — | — | — | — | 94.7 | 10 | — |
| Zirconia | $ZrO_2$ | — | — | — | — | — | — | — | — | — | | — |
| Cullet[4] | | 100.0 | 300.0 | None | 100.0 | 100.0 | None | 300.0 | 300.0 | 300.0 | 30 | 20 |

[1] Compositions for BaC 5725/574 and BaC 6109/572 are omitted; BaC 574/577 and BaC 611/588 have practically replaced them.
[2] The letter symbols for the various types of optical glass are: BSC, borosilicate crown; LC, light crown; BaC, barium crown; BF, barium flint, crown of refraction of 1.511 and a nu-value of 63.5.
[3] Powdered flint is the source of silica; for all other glasses sand is used.
[4] The amount of cullet may be varied, "none" meaning no cullet of this glass available.

ODU OPTICAL GLASS.

| Li…tium Car…bonate | Titanium Oxide | Beryllium Oxide | Zirconium Oxide | Arsenic and Antimony Oxide | Alumina Hydrated |
|---|---|---|---|---|---|
| % | % | % | % | % | % |
| < .030 | < 0.005 | < 0.020 | < 0.030 | < 0.025 | < 0.010 |
| < — | — | — | — | — | — |
| < — | — | — | — | — | — |
| — | — | — | — | — | — |
| — | — | — | — | — | > 64.3 |
| < .001 | < 0.001 | < 0.002 | < 0.003 | | |
| < .001 | < 0.001 | < 0.002 | < 0.003 | | |
| < .001 | < 0.002 | < 0.002 | < 0.003 | < 0.025 | < 0.005 |
| < .001 | < 0.001 | < 0.002 | < 0.003 | | |
| < .001 | < 0.001 | < 0.002 | < 0.003 | | |
| — | — | — | — | — | — |
| < — | — | — | — | — | — |
| < — | — | — | — | — | — |
| — | > 98.5 | — | — | — | — |
| — | — | > 99.0 | — | — | — |
| — | — | — | > 98.5 | — | — |
| 1.0 | — | — | — | — | — |

a pot varies from 5 to 10 hours, subject to the ease with which the batch melts.

One to three hours after the last fill, depending on how badly the glass foams, the stirring of the glass by machine can begin. This is accomplished by means of a refractory thimble, made of the same materials as the pot. After the stirring machine is set in place and the water-cooled rod with stirring thimble connected to the machine, the thimble is centered in the pot. The machine is raised until the end of the thimble is one-half inch above the inside bottom of the pot. The rod is then set to the diameter of stir desired, the motor started and the speed adjusted by means of a rheostat. The water-cooled rod is connected to a horizontal, motor-driven drum and works over a pulley as a fulcrum (Fig. 3). Such a device does not give a true circle as the length of the arm is not constant even when using the so-called circular stir. The type of stir used is one of continually increasing and then decreasing diameter resulting in a curtate epitrochoid type of motion as shown in Figure 4. The stirring machine has a cam that, when engaged, will automatically raise and lower the pulley which acts as a fulcrum for the stirring rod. By this means, a vertical motion can be superimposed on the horizontal motion. This vertical motion is used in the melting of dense flint glasses to replace "blocking." "Blocking" is the process of stirring and fining a melt by the introduction of a highly volatile substance, such as arsenious oxide or ammonium nitrate, which produces a sudden evolution of gas.

Previous to this stage of the operation, all temperatures are regulated from thermocouple readings; but, with the beginning of the stirring operation, temperatures are regulated from observations taken with the optical pyrometer sighted on the surface of the glass.

Some typical melting schedules are shown in Figure 5. The viscosity of those glasses for which measurements

MPO FOR OPTICAL GLASSES.[1]

*ient… Required to Make One Pot of Glass)*

| Ba… 517/… | BF 584/460 | BF 588/534 | BF 604/435 | CF 529/516 | F 572/425 | F 579/410 | F 605/381 | F 617/366 | F 620/362 | F 649/338 | F 666/324 | F 672/322 | F 689/309 | F 720/293 | F 754/277 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 466… | 656.4 | 581.7 | 603.2 | 717.3 | 754.9 | 663.8 | 725.9 | 570.0 | 595.1 | 615.9 | 609.2 | 713.9 | 625.3 | 607.0 | 561.6 |
| 1… | 247.5 | 127.0 | 307.6 | 109.7 | 434.3 | 443.8 | 628.3 | 540.0 | 589.9 | 763.9 | 843.2 | 1019.4 | 981.9 | 1110.7 | 1191.6 |
| 54… | 226.9 | 423.3 | 231.0 | 2.7 | 17.6 | 9.7 | — | — | — | — | — | — | — | — | — |
| 9… | — | 158.0 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| — | — | 62.5 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 4… | 35.1 | — | — | 246.6 | 117.1 | 8.6 | 49.5 | 98.3 | 66.9 | 17.9 | — | — | — | — | — |
| 1… | 173.7 | 75.0 | 252.2 | 50.0 | 75.0 | 72.1 | 70.0 | 61.0 | 63.0 | 140.0 | 125.7 | 217.3 | 166.9 | 122.3 | 88.9 |
| 7… | 102.4 | — | 106.9 | 39.1 | — | — | — | — | — | — | — | — | — | — | — |
| 3… | 6.6 | 6.4 | 5.3 | 2.0 | 4.1 | 3.8 | 7.6 | 6.3 | 6.5 | 7.5 | 4.7 | 5.5 | 5.1 | 5.3 | 5.4 |
| 8… | — | — | — | 20.0 | — | 6.3 | — | — | — | — | — | — | — | — | — |
| — | 40.5 | 73.6 | — | 56.2 | 87.4 | 126.8 | 149.1 | 70.2 | 66.1 | 46.9 | 50.6 | — | — | — | — |
| —… | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| —… | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 6… | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 162… | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 100… | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| —… | — | 19.1 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 300… | 200.0 | 200.0 | 200.0 | 165.0 | None | 300.0 | 100.0 | 300.0 | 300.0 | 300.0 | 300.0 | 100.0 | 300.0 | 300.0 | 300.0 |

ariu…, crown flint; and F, flint. The number designations following the letter symbols, taking BSC 511/635 as an example, mean a glass of index

**Fig. 3. A pot of optical glass is being stirred; at the same time, the furnaceman is determining the temperature of the glass with an optical pyrometer.**

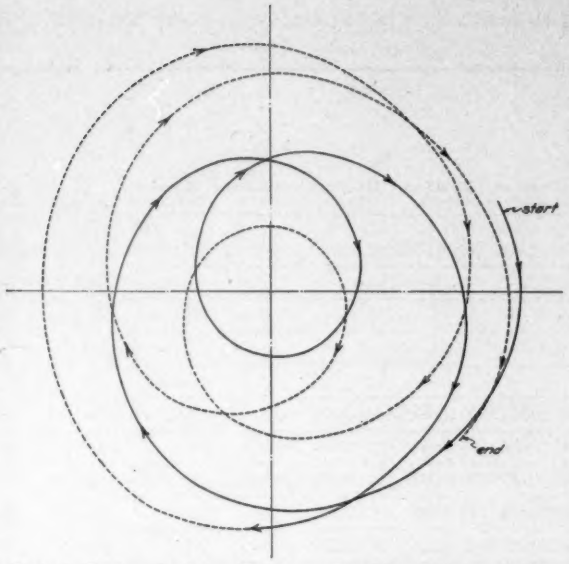


**Fig. 4. Path of the refractory thimble during stirring. This represents only a part of the complete cycle which repeats itself every 60-65 revolutions.**

are available ranges between $10^{1.65}$ and $10^{2.01}$ poises at the melting temperature. The pot of glass is maintained at the melting temperature until proofs indicate that no further improvement in the seed quality can be expected. The temperature is then reduced at the rate of approximately 50° C/hour to the fining temperature with or without a "no stir" period. The fining temperature is somewhat empirical, but is defined as that temperature at which "the molten glass approaches freedom from undissolved gases."* The glass remains at the fining temperature until proofs indicate freedom from seeds. The rate of fining of a glass is influenced by both viscosity and surface tension[5], those of high surface tension being more difficult to fine than those of low surface tension. The viscosity at the fining temperature ranges between $10^{1.87}$ and $10^{2.18}$ poises.

After fining, the pot of glass is cooled at a rate of 50° C/hour to a specified temperature (average viscosity $10^{3.3}$ poises) preparatory to removing it from the furnace. During cooling, the diameter and rate of stirring are gradually decreased. Various methods have been tried to cool the pot of glass from the bottom while it is in the furnace. Generally, the furnace door is raised about four inches and plugs in the two openings in the rear of the furnace** on a level with the floor are removed to cool the lower part of the pot more rapidly than it would normally cool during the last several hours of the melt. This procedure apparently reduces the convection currents, thereby improving the quality of the glass for striae.

The temperature at which a pot is removed from the furnace is very critical. If the pot of glass is too hot when removed, striae will be formed due to convection currents; if stirring is continued at too low a temperature (too high a viscosity), seeds will be formed in the glass. In fact, for most glasses the stirring schedule is a compromise. Seeds will be formed if the stirring is too fast; yet for the best striae quality, stirring should be as fast as possible without causing the glass to slop over. The stirring schedule finally selected is usually too fast for the best seed quality and too slow for the best striae quality.

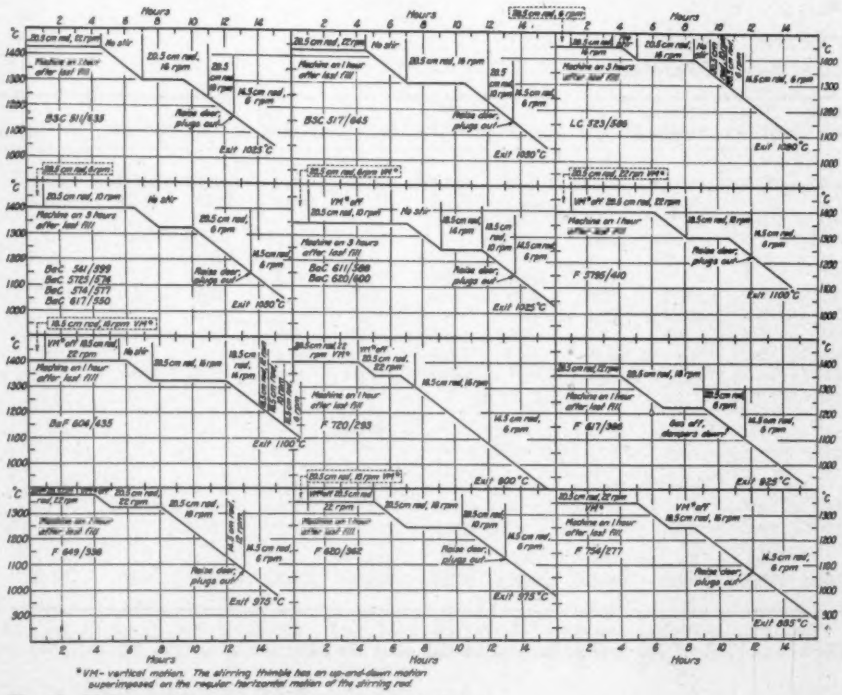


**Fig. 5. Melting schedules for various optical glasses.**

* Glass Division Standard Definitions, Bull. Am. Ceram. Soc., 26, 239 (1947).

** The use of two openings in the rear of the furnace was suggested in a private communication from J. C. Young.

† These insulated cans consist of shells (46 inches in diameter by 42½ inches tall) made of 20 gauge black sheet iron and lined with 4½ inches of insulating brick, 2,000° F series, set on end. The bricks are held in place in the shell and top by means of draw bar bolts.

**Fig. 6. Removing a finished pot of optical glass from the melting furnace.**

The thimble is removed and the pot transferred from the furnace to four brick piers for cooling (Fig. 6). An insulated can† is lowered to cover the upper third of the pot and the bottom of the pot is cooled by means of a blower (Fig. 7).

The insulated can is lowered to cover the pot completely when the temperature indicated by a thermocouple in the top of the can is within the 400°-650° C range. For flint glasses this is done in the lower end of the range and for crowns in the upper end. The covering temperature is reached in from three to seven and one-half hours after the pot is set under the can. In the case of flints 5795/410, 617/366 and 620/362, the can is raised at 250° C and the glass inspected for fracture; if none is present, the glass is left uncovered until it cracks and then covered again. The insulated can is removed at 150° C, an insulated lid placed over the top of the pot to prevent shattering of the surface of the glass and the pot left to cool to room temperature. The time necessary to cool a pot of glass to its uncovering temperature is approximately three days.

Convection currents are minimized by keeping the top hot, and any convection currents starting from the center stay on the surface instead of being forced down into the glass as they would be if the surface chilled. Cooling the bottom of the pot fixes the layer of striated glass due to pot solution.

The procedure for cooling partially anneals the glass and causes it to break into a relatively few large pieces instead of many small pieces. The partial annealing is necessary to prevent spontaneous breaking or shattering of the glass when trimmed.

5. *Breaking open the pot of glass.* The cool pot is broken open (Fig. 8)[6] and the moldable chunks of glass are boxed and weighed. At this time, samples are taken from critical locations in the pot for grading with respect to striae and seeds. Samples for index of refraction and transmission measurements also are taken.

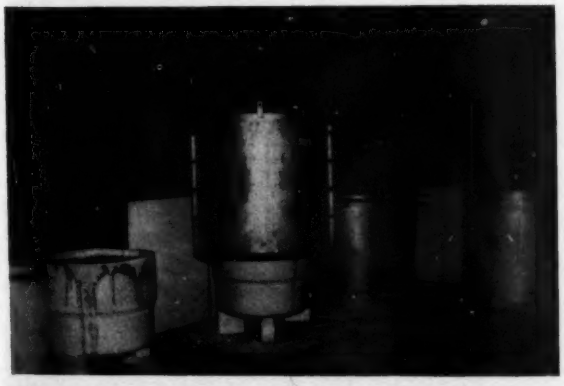

**Fig. 7. Initial cooling of a pot of glass (center); completely covered pots in the right background.**

**Fig. 8. A pot of glass after being broken open.**

Routine index measurements are made on each pot of glass by the immersion method of Faick and Fonoroff[7]. Periodically, precision index and dispersion measurements are made on fine annealed, ground and polished prisms.

The pot shell is reclaimed and is used as grog in making new pots.

6. *Preparing the rough glass for molding.* For medium and small sized blanks, the chunks of glass are broken into pieces of approximately the desired weight by means of hammers and, at the same time, striae and other imperfections are trimmed out. The hammers have square heads of casehardened steel and the face must be ground at least once during each shift to maintain sharp edges. Otherwise, marks may be left on the glass and it may not break properly. The glass for large blanks is trimmed to the proper weight by means of a diamond saw which is also used for removing striae and other imperfections marked by the inspector. The waste glass from the trimming operations is used as cullet for succeeding melts.

7. *Molding.* a) Small blanks (up to 0.25 pound). Paddling. Small blanks can be molded by procedure b) which follows. However, it is generally more economical to mold them by the paddling process. The rough glass is molded into a flat of appropriate thickness which, after scoring with a diamond, is then broken into cubes of a weight somewhat more than that desired in the finished blank. The cubes are then ground down to weight, the corners and sharp edges being removed in the process. The pieces are placed in the cooler section of a small gas-fired furnace, the floor of which is heated by radiation from the crown. The slabs used for the bottom of the furnace are alundum with a veneer on top that gradually dusts, thereby keeping the glass from

(*Continued on page* 586)

# INVENTIONS AND INVENTORS

## A Summary of Recently Issued Patents of Interest to the Glass Industry

### Furnaces

*Laclede-Christy Tank. Fig. 1. Patent No. 2,448,451.* This tank, and the method of using it, is the invention of John H. McKelvey and John W. Rogers of Kirkwood, Mo., who assigned the patent to Laclede-Christy Clay Company.

The figure shows a perspective view of a tank cut down the middle with a part of the wall nearer the observer drawn on a smaller scale. The tank has the usual floor 1, side walls 2, end walls 3 and a bridge-wall 4. The ports are made about as usual except for the tuck-stones 5. Two earlier patents to these inventors, Nos. 2,077,705 and 2,163,405, disclose tanks having certain advantages but this invention is an improvement over those patents.

Cold air under pressure is supplied by a main 20 to manifolds 21 having branches 22 leading to headers 13. These headers extend along the walls at the melting end of the furnace and discharge air through a narrow space below the tuck-stones and the tank walls. This space is shown at 14 and may be somewhere around an inch high. Gates 24 in the branches 22 provide means for regulating the flow of air. The air from this space prevents sting-out and cools the glass adjacent the walls, thereby reducing wear on the walls. It is desirable to have a larger volume of air on the side where the flame is being exhausted through the ports and this may be done by valves 25 in the air supply line 20. The arrows show the flow of air near the side walls.

The bridge-wall 4 has a similar cooling system provided by a header 17 which discharges air through passageways formed in the bottom of the cover blocks 18. The end wall is provided with a header 130 which discharges air through the space 14. A tank constructed and operated in accordance with the method of this patent, may be expected to have a considerably longer life.

The following references are of record in the file of this patent: United States Patents: 1,034,824, Owens, Aug. 6, 1912; 1,237,283, Bergman, Aug. 21, 1917; 1,967,025, Goodwillie, July 17, 1934; 2,010,055, Brown, Aug. 6, 1935; 2,042,560, Stewart, June 2, 1936; 2,056,531, Morton, Oct. 6, 1936; 2,119,947, Blau et al., June 7, 1938; 2,163,405, McKelvey et al., June 20, 1939; 2,199,355, Underwood, Apr. 30, 1940; 2,212,358, Weekley, Aug. 20, 1940; and 2,246,053, Magrini, June 17, 1941. Foreign Patents: 6,204, Great Britain, Mar. 22, 1899.

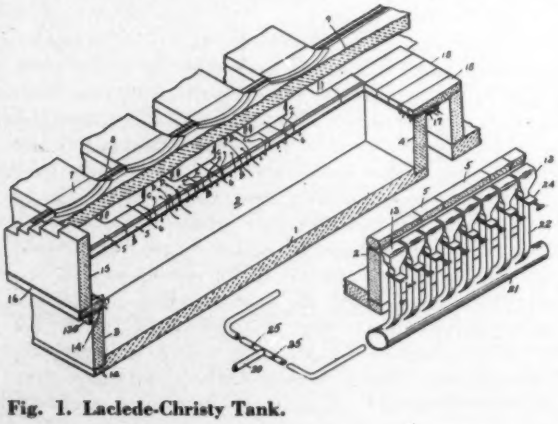

Fig. 1. Laclede-Christy Tank.

### Feeding, Forming and Shaping

*Machine for Forming Bottoms on Tubes. Fig. 2. Patent No. 2,447,568.* Charles Eisler has added another patent to the large number owned by his company. This one relates to an automatic machine for forming a bottom of precise shape and thickness on an open ended blank or tube. One use for the machine is in the manufacture of pistons for syringes in which exact shape is of great importance.

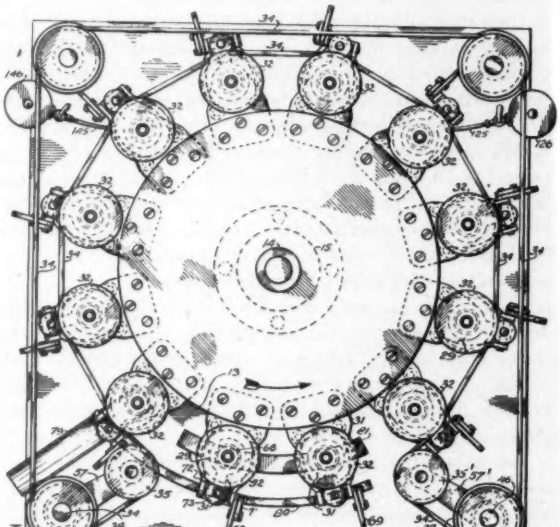

Fig. 2. Machine for forming bottoms on tubes.

The drawing shows a plan view of the machine which comprises a spider 13 fixed on a shaft 14 by which it is intermittently advanced to a series of working stations. There are 12 chucks 29 of the usual construction mounted on the spider. The chucks are rotated by a belt 34 passing around pulleys 32 connected to each chuck. The belt is driven by pulleys 36 and 37 which are connected to a suitable motor.

The drawing shows a chute 79 down which the finished product is discharged. From there the heads move in the direction of the arrow, first to a loading station where a tube or blank is inserted in the chuck. The tube then passes through stations where it is heated and then to stations where it is preformed and then subjected to heat to burn off the waste below the constriction made

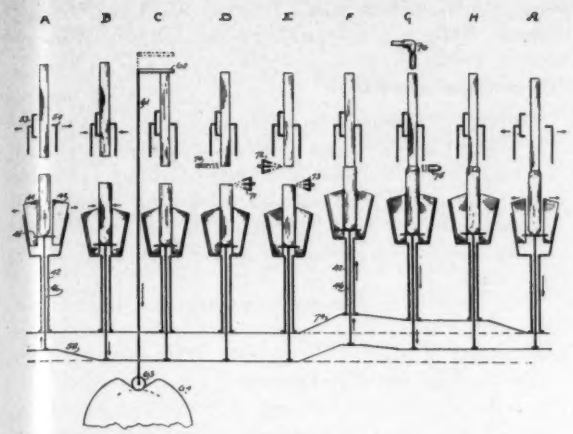


**Fig. 3. Eisler Tubulating Machine.**

at the preforming station. At a later station a bottom forming tool is introduced into the tube, proper heat is applied and a flat bottom is formed on the tube. All of the operations are automatic but they may be stopped manually at any point if found necessary.

The following references are of record in the file of this patent: United States Patents: 621,794, Colburn, Mar. 28, 1899; 1,034,419, Catucci, Aug. 6, 1912; 1,330,-707, Hoffstetter et al., Feb. 10, 1920; 1,532,077, Quackenbush et al., Mar. 31, 1925; 1,735,027, Wetmore, Nov. 12, 1929; 1,816,280, Dawson et al., July 28, 1931; 1,914,205, Hooper et al., June 13, 1933; 1,981,692, Dichter, Nov. 20, 1934; and 2,101,213, Dichter, Dec. 7, 1937. Foreign Patents: 282,057, Great Britain, Mar. 22, 1928.

*Eisler Tubulating Machine. Fig. 3. Patent No. 2,477,-569.* This is another patent in the series granted to Charles Eisler. The object of the machine is to join two tubes of different diameter so as to make a union of the desired shape and of good strength and appearance.

The figure reproduced here shows diagrammatically the several steps carried out automatically on an intermittent turret type machine. At a loading station A, the lift shaft 46 is raised by the cam 58 which opens the jaws 44 of the chuck. The tube of greater diameter is placed in the chuck 44 while the tube of less diameter is placed in the chuck jaws 53 and 54. At station B the chuck jaws have been closed.

When the parts reach station C, the upper tube is positioned vertically by an arm 60 mounted on a rod 61. The lower end of this rod has a cam roller 63 which is moved vertically by a cam 64.

The head then moves to station D where the ends of both tubes are softened by burners 70 and 71 and still further at station E where the tubes are heated by burners 72 and 73. At station F the lower tube is raised into contact with the upper tube by the cams 58 and 74 at which time the tubes are fused together. At station G the fused joint is elongated slightly by the cams while compressed air is applied to the interior of the tubes from a nozzle 76. At the same time the joint is heated by a moderate fire from a burner 75.

At station H the welded tube is cooled and the chuck is opened on the way from station H to the starting station A where the joined tube is manually removed after opening the jaws 53 and 54. The result is a tube having a superior appearance and strength.

The following references are of record in the file of this patent: United States Patents: 1,621,359, Fagan et al., Mar. 15, 1927; 1,742,153, Stiles, Dec. 31, 1929; 1,813,-105, Wetmore, July 7, 1931; 2,023,628, Van Sant, Dec. 10, 1935; and 2,151,840, Dichter, Mar. 28, 1939. Foreign Patents: 363,916, Great Britain, Dec. 31, 1931, and 368,419, Great Britain, Mar. 10, 1932.

*Suction Mold. Fig. 4. Patent No. 2,448,632.* This is an invention by Arthur E. Smith, Darling Point, Sydney, New South Wales, Australia. Apparently this mold might be used with a machine like the old Owens Suction Machine. The principal object of the invention is to remove the air from the interior of the mold when the glass is drawn into the mold cavity.

In the figure, 10′ shows one half of the mold having a cavity 11 and one half 12′ of a split mold head sometimes called a neck ring. A suction head 13 connected with a vacuum pipe 14 seats on the mold. A valve mechanism is provided so that the vacuum can be turned on and off at the proper times. A core 19 may be suspended in the mold cavity and it is stated that this may be formed of core sand. It is not explained how the sand core works with glass.

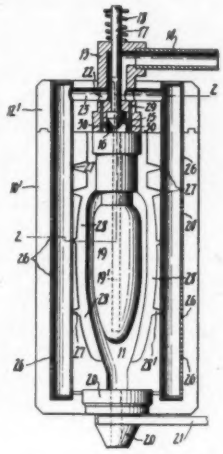

**Fig. 4. Suction Mold.**

The suction head 13 communicates by means of holes 22 and 23 with suction tubes 24 extending vertically off the mold. These tubes are provided with small openings 26 and 27 which exhaust the air from the joint between the mold halves and from the mold cavity. The bottom of the mold is closed by a suction nozzle 20 carried by a bracket 21. Thus when the suction nozzle is dipped into "molten metal" such as glass, air leaking in through the joint between the mold halves will be exhausted. The porous core 19 has its interior connected with the source of vacuum so that air is also drawn out through it. Several alternative constructions are shown in the patent.

The following references are of record in the file of this patent: United States Patents: 1,223,392, Kadow, Apr. 24, 1917; 1,792,988, Kadow, Feb. 17, 1931; 1,879,-872, Hofmann, Sept. 27, 1932; and 2,175,407, Peiler, Oct. 10, 1939.

*Glass Feeder. Fig. 5. Patent No. 2,448,915.* This patent shows a machine for feeding mold charges or gobs of molten glass to the associated forming machine. It is the invention of Arthur W. Schmid of Brookside Farm, Pa. The glass is delivered pneumatically instead of mechanically as by a reciprocating plunger.

In the figure, there is shown a forehearth 1 having a boot 2 enclosed by a cover 3. The outlet is cone shaped as defined by the wall 2a. An orifice ring 5 determines the diameter of the gob to be discharged. A refractory valve 4 has a flat bottom 7 and is mounted on a beam 10 by which it may be adjusted vertically by means of a hand wheel 11.

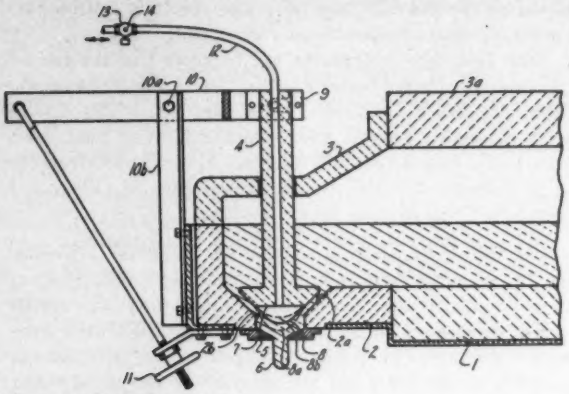

**Fig. 5. Glass Feeder.**

The hollow interior of the valve 4 is connected to a pipe 12 in which positive and negative air pressures may be set up by the operation of a valve 13 having a bleeder 14 to adjust the intensity of the air pressure. Several glass levels are indicated above the orifice ring. The numeral 8 shows the gravity flow level; 8a is the lowest level at the end of the extrusive pressure and 8b is the upper level at the end of the retractive pressure. This feeder is said to be a great improvement over the conventional hollow bell type pneumatic feeder.

The following references are of record in the file of this patent: United States Patents: 1,574,709, Soubier, Feb. 23, 1926; 1,796,929, Howard, Mar. 17, 1931; 1,847,276, Stenhouse, Mar. 1, 1932; 1,995,276, Howard, Mar. 19, 1935; 2,048,983, Wadsworth, July 28, 1936; 2,055,676, Stewart, Sept. 29, 1936; and 2,131,242, Wadsworth, Sept. 27, 1938. Foreign Patents: 10,560, Great Britain, May 4, 1909.

### Glass Compositions

*Corning Insulating Glass. Patent No. 2,449,099.* This glass composition is particularly adapted for use as insulating laminae in electrical condensers and for sealing iron conductors into tubes of electronic devices. It is the invention of William H. Armistead, who assigned it to Corning Glass Works. This patent is an improvement over two prior patents, Nos. 2,431,980 and 2,414,504.

The following table gives five examples of glasses falling within this invention and calculated in per cent by weight from their respective batches, together with their properties:

TABLE II

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| $SiO_2$ | 45 | 45 | 45 | 40 | 38.7 |
| PbO | 25 | 17.5 | 10 | 30 | 30 |
| BaO | 10 | 17.5 | 25 | 20 | 20 |
| $K_2O$ | 12.6 | 12.6 | 12.6 | 7 | 7 |
| $Na_2O$ | 5.4 | 5.4 | 5.4 | 2.5 | 1.8 |
| $Li_2O$ | 2.0 | 2.0 | 2.0 | .5 | .5 |
| $Na_2SiF_6$ | ... | ... | ... | ... | 2 |
| Power Factor, per cent | .043 | .043 | .043 | .047 | .043 |
| Dielectric Constant | 8.2 | 8.3 | 8.3 | 8.8 | 8.8 |
| Temp. Coeff. P. P. M. per °C. | ... | ... | ... | 120 | 120 |
| Softening Temp., °C | 524 | 543 | 553 | 590 | 575 |
| Expansion Coeff. $\times 10^7$ | 123.3 | 121.7 | 128.2 | 106.6 | 107 |

The following references are of record in the file of this patent: United States Patents: 2,018,816, Taylor, Oct. 29, 1935, and 2,018,817, Taylor, Oct. 29, 1935.

### Glass Wool and Fiber

*Method of Making Glass Fibers. Fig. 6. Patent No. 2,448,499.* Carl C. Swann of Kingsport, Tenn., invented this method and assigned it to Owens-Corning Fiberglas Corporation. An early method of making glass fibers is shown in Patent No. 2,325,640 to Thomas and Fletcher but the present invention has certain advantages over that patent.

This invention has several novel features, including a new method of winding the strand onto the spool and a new method of twisting the strands. This calls for little or no binding material heretofore always needed. In Fig. 6 there is shown a bushing 10 from which numerous fibers 12 are drawn continuously. These may pass over a pad 13 which gathers the fibers into a strand 14 and may apply a lubricant or binder. The strand then goes to a guide 16 which encloses the spool on which the strand is wound. The spool does not show in the figure but it is held stationary inside the cap 17 carrying the guide 16. The guide rotates and reciprocates vertically, thus winding the strand on the spool and also traversing the wind longitudinally of the spool.

The cap 17 is actuated by a shaft inside a fixed tube 20 mounted on a plate 21 fixed to the frame 22. This arrangement produces a twist in the strand as it passes from the pad 13 to the guide. The cap is driven by a motor connected to a pulley 29 having a belt 31 driving a pulley 30 fixed on the drive shaft inside the tube 20.

The reciprocation of the guide is produced through a plate 26 mounted on the top of a pair of rods 33 which are connected to a cam 38 by a lever 45. Various adjustments are provided and safety features are found where necessary. The cap 17 is easily removed for the removal of the completed spool and the insertion of an empty one.

The following references are of record in the file of this patent: United States Patents: 1,168,927, Bibby, Jan. 18, 1916, and 1,505,585, Clough, Aug. 19, 1924, Foreign Patents: 481,126, Great Britain, Mar. 7, 1938.

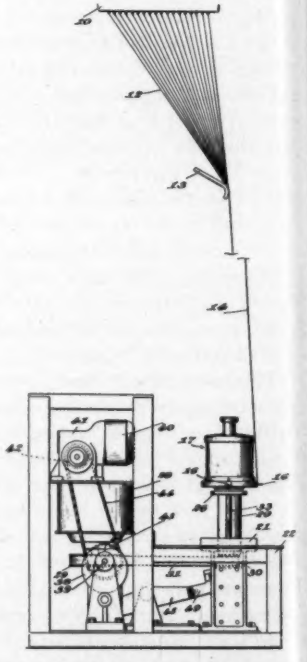

**Fig. 6. Method of Making Glass Fibers.**

### Miscellaneous Processes

*Glass Fiber Reinforcement for Plastics. Patent No. 2,446,119.* This is an invention by Erven White, Robert Steinman and Lawrence P. Biefeld, all of Newark, Ohio, who assigned the invention to Owens-Corning Fiberglass Corporation.

It is not new to use glass fibers to reinforce

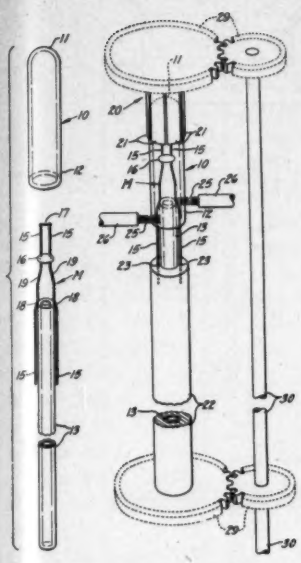

**Fig. 7. General Electric Sealing-in Method for Lamps.**

plastics but the result has not been satisfactory heretofore due to the fact that there was not sufficient adhesion between the glass and the plastic to give the desired strength. Numerous reasons have been advanced to account for this. One reason was that the plastic did not completely wet the glass. Several other reasons were suggested but none resulted in a remedy. Many processes have been suggested but for one reason or another, none were successful. Now these inventors have found that coating the glass fibers with heat treated dextrinized starch will give such good adherence that the strength of the product will be greatly improved.

One example of this sizing composition is:

| | |
|---|---|
| Starch or dextrinized starch..... | 3 to 15% |
| Oil ..... | 1 to 5% |
| Cationic-active substance ..... | 0.1 to 1% |
| Wetting agents, etc., about..... | 4% |
| Water to make up..... | 100% |

This sizing composition is sprayed or wiped onto the fibers immediately after forming which provides a good lubricating coating to prevent the fibers from seizing and abrading each other. Certain other advantages are apparent after the use of this sizing. After the application of the sizing, the fibers are heat treated at a temperature of about 200°C for a period of from ½ to 3 hours according to the degree of adhesion desired. This fixes the starch to the fiber and removes any moisture from the surface of the glass. The resin is then applied in the usual manner. The result is a sheet having greatly improved qualities.

The following references are of record in the file of this patent: United States Patents: 741,592, Roberts, Oct. 13, 1903; 1,981,292, Todd et al., Nov. 20, 1934; 2,138,882, Robie, Dec. 6, 1938; 2,234,986, Shayter, Mar. 18, 1941; 2,341,219, Jones, Feb. 8, 1944; and 2,370,046, Keyes, Feb. 20, 1945.

*General Electric Sealing-in Method for Lamps. Fig. 7. Patent No. 2,447,158.* This patent is the invention of Paul O. Cartun of Cleveland Heights, Ohio, who assigned it to General Electric Company. The invention has several uses but it is explained as used in the manufacture of incandescent lamps for use with telephone installations.

The inventor has found that the many difficulties encountered in previous methods may be avoided by externally heating the bulb neck and allowing it to contract and coalesce spontaneously with the end of the exhaust tube. This makes it convenient to seal in a simple mount with lead wires.

Fig. 7, which is an exploded view on the left, shows a bulb blank 10 having a closed end 11 and an open mouth 12. An exhaust tube 13 comprises a mount M having lead wires 15, 15, a glass bead 16 and a tungsten filament 17. The size of the parts may be judged by the fact that the blank 10 may be about 1 inch long and ¼ inch outside diameter. Other parts are proportionately small.

The right of the figure shows the parts assembled for the sealing in operation. The blank 10 is held in a chuck 20. The tube 13 is held in a spindle 22 in proper relation to the other parts. By a proper regulation of the heat from the burners 26 the neck 12 is softened so that a welded joint is formed.

The chuck and spindle are preferably rotated with relation to the burners, by means of gears, 29, 29 and a shaft 30 connected to the chuck and spindle as shown at the right of the figure. After the sealing operation the lamp is exhausted through the tube 13 in the usual way. This provides a simple mechanism for making a more satisfactory seal than has heretofore been possible.

The following references are of record in the file of this patent: United States Patents: 1,547,748, Grogan, July 28, 1925; 1,569,185, Higgins, Jan. 12, 1926; 1,647,999, Laskey, Nov. 8, 1927; 1,701,388, Remane, Feb. 5, 1929; 1,984,488, Mulder, Dec. 18, 1934; 2,020,729, Knoeppel, Nov. 12, 1935; and 2,028,342, McGowan, Jan. 21, 1936.

*Glass Cleaning Material. Fig. 8. Patent No. 2,447,297.* This patent was assigned to Wyandotte Chemicals Corporation by the inventors, Walter F. L. Wegst, Leslie R. Bacon and Thomas H. Vaughn. The material is useful in cleaning and protecting the surface of glass containers such as milk bottles. The materials heretofore most commonly used were caustic soda and the carbonates, orthophosphates and silicates of soda.

Bottles which are frequently washed by commercial methods soon show what is called "scuffing" which is

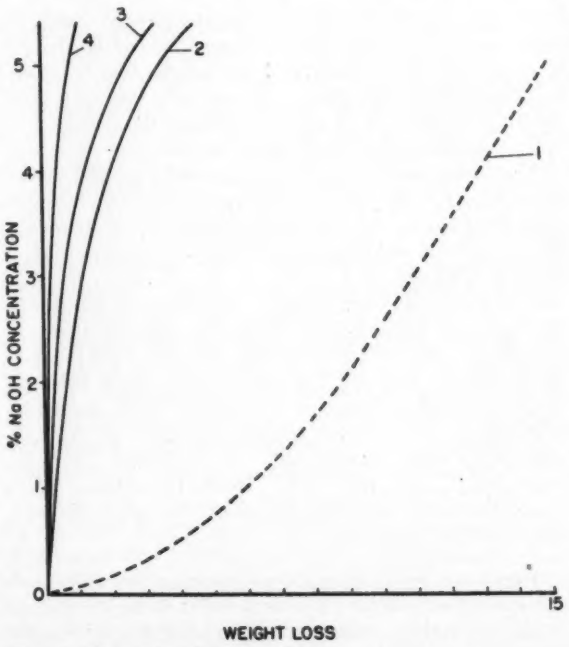


**Fig. 8. Glass Cleaning Material.**

caused by a combination of chemical attack and mechanical abrasion. This may weaken the bottle considerably. This scuffing shows particularly on raised lettering and labels fused onto the bottles. This, of course, spoils the looks of the bottle. These inventors have found that the addition of zincated alkalis to the washing compound not only retards abrasion but increases the germicidal activity of the compound.

The patent gives several examples of compositions for practicing the invention, one of which is as follows: New glass bottles weighing approximately 393±3 grams were exposed to the action of alkali bottle washing solutions for a period of six days and at a temperature of 185±5°F; the degree of alkali attack by a straight caustic soda solution on the one hand, and by a zincated caustic soda solution on the other hand, upon these bottles, as determined by the loss in weight of the individual bottles, is shown in the following table:

| Composition of Solution | Per Cent ZnO, by Weight (On Total Alkali Basis) | Weight Loss After Alkali Exposure, Brushing and Drying |
|---|---|---|
| Caustic Soda (NaOH): | | *Mg.* |
| 1% by Weight | 0 | 749 |
| 3% by Weight | 0 | 1,180 |
| 5% by Weight | 0 | 1,471 |
| Caustic: Zincate Ratio * ($NaOH:Na_2ZnO_2.4H_2O$): | | |
| 95:5 at— | | |
| 1% by Weight | 1.9 | 13 |
| 3% by Weight | 1.9 | 151 |
| 5% by Weight | 1.9 | 413 |
| 90:10 at— | | |
| 1% by Weight | 3.8 | 2 |
| 3% by Weight | 3.8 | 36 |
| 5% by Weight | 3.8 | 155 |
| 80:20 at— | | |
| 1% by Weight | 7.6 | 3 |
| 3% by Weight | 7.6 | 9 |
| 5% by Weight | 7.6 | 44 |

* Zn content calculated to $Na_2ZnO_2.4H_2O$.

The results of the above table are further shown in Fig. 8 where the weight loss is plotted against the NaOH content. Curve 1 shows how the weight loss increases with increasing concentration in case of a straight NaOH solution. Curves 2, 3 and 4 represent the weight loss when using the solutions of the above table.

The inventors cannot give any precise scientific theory as to why this composition acts as it does but repeated tests have shown that the invention works which should be enough for anybody. The value of the invention is clearly apparent.

The following references are of record in the file of this patent: United States Patents: 546,206, Wachter, Sept. 10, 1895; 674,593, Bartelt, May 21, 1901; 1,267,737, Bartelt, May 28, 1918; 2,035,652, Hall, Mar. 31, 1936; 2,085,966, Foster et al., July 6, 1937; 2,087,264, Poisner, July 20, 1937; 2,155,045, Griffith et al., Apr. 18, 1939; 2,241,984, Cooper, May 13, 1941; and 2,289,578, Hull et al., July 14, 1942. Other References: Soap, December 1936, page 69. Chemical Formulary, Bennett, vol. 4 (1939), page 507.

*Vacuum Tube Machine. Fig. 9. Patent No. 2,447,522.* This is a machine for forming circular stems on vacuum tubes and sealing conductor wires in the stems. It is the invention of William R. Moscrip of London, England,

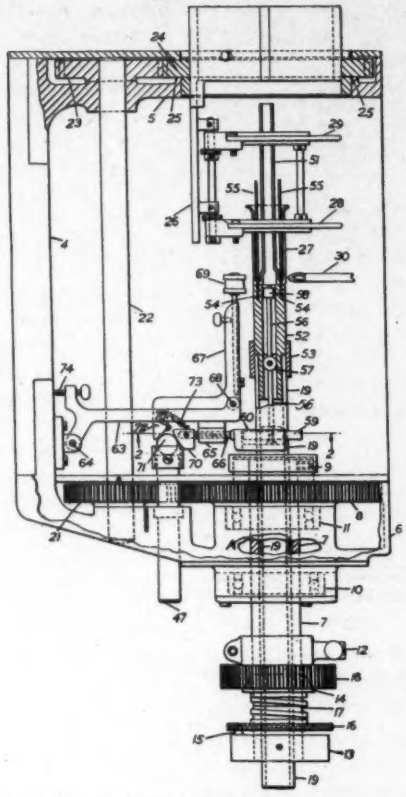

**Fig. 9. Vacuum Tube Machine.**

who assigned it to International Standard Electric Corporation of New York.

The invention is preferably a head to be used on a turret type machine but such use is not necessary as the head may be used as a single unit. Fig. 9 shows a head consisting of an upright 4 and upper and lower members 5 and 6. There is a vertical tube 7 carrying a fixed gear 8, this tube being driven through a gear 18. The tube is driven through a friction drive comprising the spring 17 and associated parts 13, 14, 15 and 16 which allows the rotation of the tube to be stopped while the gear 18 continues to run.

A smaller tube 19 fits inside the tube 7 and is keyed so that it is driven by the tube 7 but slides vertically therein, this connection being shown at A. The gear 8 drives a gear 21 on a shaft 22 having a gear 23 at its upper end. This gear meshes with a gear 24 which carries a stem holder 26 adapted to grasp a stem blank 27 and an exhaust tube 51. This mechanism drives the upper and lower parts of the apparatus at the same speeds. A hollow die 52 is held in alignment with the tube 19 by a collar 53 and the die has holes to receive the conductors 55 which are to be sealed.

A lever 63 actuates the working parts which make the seal. After the parts are placed in position, the glass is heated by a burner 30 and the rollers 69 are moved in to press the parts together. The patent should be seen for details of construction and operation.

The following references are of record in the file of this patent: United States Patents: 418,235, Schulze-Berge, Dec. 31, 1889; 1,006,383, Johns, Oct. 17, 1911;

(*Continued on page* 582)

# Research Digest

### Automotive Glazing With Plastics

During the past several years, synthetic resin plastics that have properties of transparency and rigidity comparable to glass have been developed. Such plastics are serving the purpose of glass in certain limited applications at the present time. Because of the lower density of these materials and their ease of fabrication into curved sections, consideration is being given to their application for glazing postwar cars. To determine or establish the suitability of plastics for motor car glazings, a study, including laboratory tests and practical glazing tests, has been made by Watkins and Ryan, of three commercially available plastics, namely, polymethyl methacrylate plastics, including Lucite and Plexiglas, and CR-39 (this is now known as allyl diglycol carbonate). The results of this study are given in the August 1948 issue of the *A.S.T.M. Bulletin.*

For evaluation purposes, laboratory wise, these three plastics were subjected to the qualifying tests as established by the A.S.A. in the Safety Glass Code Z26.1, with the following results (condensed from the original paper):

*Stability Test:* A—Discoloration Test (irradiation with ultraviolet light for 100 hr. at a distance of 9 in.)—All specimens suffered a higher loss in light transmission percentage-wise than laminated safety glass, but their light transmission of 85 to 88 per cent after test was well above the standard test minimum of 70 per cent. Plexiglas and Lucite showed surface decomposition, while CR-39 plastic did not. It was believed that the test method should be modified for the evaluation of plastics as automotive glazings, in practice, never are submitted to such intense U.V. When a less intense U.V. source was used, all three plastics were comparable in stability, even after very prolonged exposure.

B—Humidity Test—The specimens, when placed in the 70 per cent relative humidity atmosphere as required for a period of two weeks, showed no change, thus complying with the requirements.

C—Boil Test (2 hr. immersion in boiling water)—All three plastics developed warpage but without bubble development. If warpage is considered objectionable, the test specification should be modified as it was originally written for glass which at high temperatures has greater form stability.

*Impact Test*—The qualifying impact tests as established by the Code for the three types of Safety Glass are listed in Table I.

Table II gives the results obtained when ¼ in. thick specimens, 12 in. by 12 in. size, of the three plastics were subjected to some of the above conditions.

*Visibility Distortion Test*—In the case of visibility distortion, the procedure set up by the Code allows a maximum deviation of 5.73 min. (applicable only to windshields). The samples of ¼ in. Lucite and ¼ in. CR-39 (ten samples) passed the test while three of the ten samples of ¼ in. Plexiglas showed a deviation greater than 5.73 min.

TABLE I

SAFETY GLASS—IMPACT TEST REQUIREMENTS

| Type of Safety Glass | Kind of Impact | Requirements |
|---|---|---|
| Laminated | ½ lb. steel ball-16 ft. drop | 80% support |
| Laminated | 7 oz. dart-10 ft. drop | 100% support |
| Heat-strengthened | ½ lb. steel ball-10 ft. drop | 100% support |
| Heat-strengthened | 11 lb. shot bag-8 ft. drop | 100% support |
| Wire glass | 7 oz. dart-10 ft. drop | 100% support |

TABLE II

PLASTICS—RESULTS OF IMPACT TESTS

| Type of Plastic | ½ lb. Steel Ball 16 ft. drop | ½ lb. Steel Ball 10 ft. drop | 11 lb. Shot Bag 8 ft. drop | 7 oz. Dart 10 ft. drop |
|---|---|---|---|---|
| CR-39 | 1 out of 10 samples failed | No failures | 4 samples tested 50% failed | 4 samples tested 1 failed |
| Plexiglas | No failures | No failures | No failures | No failures |
| Lucite | No failures | No failures | No failures | No failures |

*Abrasion Resistance*—While the Code does not place any requirement on the resistance to surface abrasion of safety glass for motor car glazing, it seems that in the case of plastics, due to their relative ease of surface destruction by scratching, cleaning, rubbing, etc., that a minimum "Resistance to Abrasion Factor" be established. In this study, the Taber Abrasion Test was used. The results obtained are shown below in Table III:

TABLE III

PERCENTAGE OF SURFACE DESTRUCTION AS MEASURED BY LIGHT SCATTERING

| Type of Plastic | 100 Revolutions | 200 Revolutions | 500 Revolutions |
|---|---|---|---|
| ¼ in. Lucite | 10.0 | 10.7 | 10.5 |
| ¼ in. Plexiglas | 12.6 | 12.6 | 7.6 |
| ¼ in. CR-39 | 3.9 | 5.4 | 11.1 |
| Plate glass | 0 | 0 | 0 |

Results obtained during the past several years of experimental work, using every known hardness and abrasion resistance test, definitely indicate that glass is very substantially superior to any presently known transparent plastic from the standpoint of scratch and abrasion resistance. To illustrate, CR-39 plastic, recognized as the best today from the standpoint of abrasion resistance, is easily and readily scratched by such glass polishing and cleaning agents as rouge or Bon Ami.

*Fire Hazard*—Gasoline was poured on the surface of methacrylate plastic and ignited. The plastic did not ignite sufficiently to make the flame self-propagating. Its surface was ruined, however, and the sheet buckled or bowed.

In the practical service tests, three automobiles were glazed at various positions with the three plastics. De-

tailed notes were kept by each car operator regarding the performance of the plastic glazings. Also, photographs were made through and of the windshields at the time of glazing and after removal to illustrate the amount of distortion, as well as surface destruction occurring in service. For comparative purposes, similar photographs were made of the laminated safety plate glass windshields.

As a result of both laboratory and service tests, the following general comments and conclusions regarding plastic glazings can be made:

1—Plastic glazings are extremely difficult to clean because the road scum does not wash off as readily as from glass surfaces. Further, during wiping to dryness, annoying static developed on the plastic surfaces picking up dust.

2—Water did not wet the plastics to the same extent as it did the glass tending to stand up in droplets which were difficult to remove with the windshield wiper. In body lights, vision was hampered by these water droplets.

3—As the surface of the windshield deteriorated due to the rubbing action of the wiper, it was almost impossible to drive into the sun or bright headlights at night.

4—The low thermal conductivity of the plastics prevented the heater from removing ice and snow as rapidly as in the case of glass. Sleet and ice had to be removed by the means of boiling water as scraping would have damaged the surface.

5—There is a greater tendency on the part of plastic glazings to rattle and is probably due to their greater resiliency.

6—The three plastics are considerably more resistant to impact than ordinary sheet or plate glass and to that extent are safer when used for automobile glazings. When ruptured, however, sharp, dagger-like particles, similar to ordinary glass, are produced.

7—¼ in. CR-39 satisfactorily passes the following Code Test requirements for laminated safety glass: Uviarc Discoloration Test, Humidity Test, Boil Test (with reservations because it underwent warpage), Visibility Distortion Test and ½ lb. Steel Ball-16 ft. Drop Test.

8—¼ in. CR-39 satisfactorily passes the following Code Test requirements for heat-strengthened glass: ½ lb. Steel Ball-10 ft. Drop Test, but fails to pass the 11 lb. Shot Bag-8 ft. Drop Test.

9—¼ in. Lucite satisfactorily passes the following Code test requirements for laminated safety glass: Humidity Test, Boil Test (with reservation, because it underwent warpage), Visibility Distortion Test, ½ lb. Steel Ball-16 ft. Drop Test, and the 7 oz. Steel Dart-10 ft. Drop Test. But fails to pass the Uviarc Discoloration Test.

10—¼ in. Lucite satisfactorily passes the following Code test requirements for heat-strengthened glass: ½ lb. Steel Ball-10 ft. Drop Test and 11 lb. Shot Bag-8 ft. Drop Test.

11—¼ in. Plexiglas satisfactorily passes the following Code test requirements for laminated safety glass: Humidity Test, Boil Test (with reservations, because it underwent warpage), ½ lb. Steel Ball-16 ft. Drop Test and the 7 oz. Steel Dart-10 ft. Drop Test. But fails to pass the Uviarc Discoloration Test.

12—¼ in. Plexiglas satisfactorily passes the following Code test requirements for heat-strengthened glass: ½ lb. Steel Ball-10 ft. Drop Test and 11 lb. Shot Bag-8 ft. Drop Test.

13—Plexiglas and Lucite are equally as stable to sunlight as CR-39 in spite of the fact that CR-39 passed the Code test, while Plexiglas and Lucite failed. In other words, while CR-39 is stable to the extremely intense radiation of the Uviarc called for in the Code Discoloration Test, all three plastics are of comparable stability when exposed to a less intense source of radiation.

14—Glass materially excels CR-39, Plexiglas, and Lucite from the standpoint of scratch resistance, since polishing and cleaning agents used on glass, such as rouge and Bon Ami, instantly scratch all three plastics.

15—The life of Plexiglas or Lucite in the windshield under average conditions using the wiper occasionally ranges from 30 to 45 days. Beyond the 30-day period, driving with the abraded windshield is dangerous, inasmuch as it was difficult in making turns to ascertain the location of the curb or whether or not a pedestrian was standing on the curb or in the highway.

16—The life of CR-39 windshields subjected to occasional windshield wiper action is at best not more than 60 to 180 days.

17—Safety plate glass windshields, from the standpoint of vision, are far superior after three to four years' service to CR-39, Plexiglas, and Lucite after a few weeks' service.

18—During three to four years' service in an automobile, safety plate glass windshields suffer a slight amount of scratching which, however, is not visible looking directly through the windshield.

19—All CR-39, Plexiglas, and Lucite body lights, after 12 months of service, show numerous scratches varying from hairline to deep scratches. These scratches were not so annoying at the end of one year's service that an impartial observer would feel their replacement was imperative.

20—Plastic glazings do not present a serious fire hazard, but certainly afford less protection than glass glazings from this standpoint.

21—Plastic glazings on rupture, either from sources within or without an automobile, leave sharp, cutting edges that are as hazardous as ordinary plate or sheet glass. In this respect, CR-39 is worse than Plexiglas or Lucite, since for any given impact more fragments are formed.

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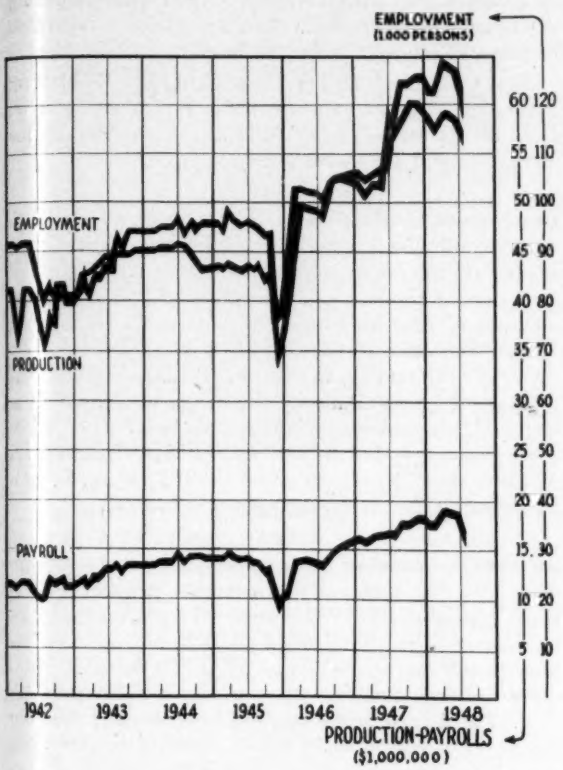
## FOREIGN TRADE AND EXPORT STATISTICS GLASSWARE REPORT

From a 1947 glassware report on foreign trade and export statistics, it is shown that the total export business keenly feels the loss of Canadian business and of other countries which seems to arise from two causes.

First, foreign countries hesitate to spend their available U. S. dollars for what they consider to be less essential glassware and, therefore, refuse to issue permits to their subjects for its importation. Second, as European countries rehabilitate their glassware industry based on low wage rates as compared with this country's present standards, their glass products become low price competition to U. S. produced ware in countries throughout the world.

# CURRENT STATISTICAL POSITION OF GLASS

## THE GLASS INDUSTRY'S INDEX




July activity in the glass industry as shown by the Production Index dropped 9 per cent to an approximate $57,500,000 from the $63,300,000 reported for the previous month. During the month of July 1947, production was estimated to be $58,700,000, which is about 2 per cent above July 1948. Production has reached an estimated total of $437,800,000 thus far in 1948, which is about 8 per cent above the $402,200,000 reported for the same period in 1947.

**Employment and payrolls:** Employment during the month of July 1948 has decreased 5 per cent from the 116,500 persons employed during June to a figure of 110,000. During July 1947, employment was 113,000, which is about 2½ per cent above July this year.

Estimated payrolls for July 1948 were $16,000,000, which is about 9 per cent below the $17,750,000 reported for June. Payrolls during July 1947 were approximated at $16,400,000, which is slightly higher than for this year. Glass manufacturers have paid out an estimated total of $113,750,000 during the first seven months of 1948, as compared with $112,900,000 paid out during the same period in 1947—a difference of close to 1 per cent.

**Glass container production** for the month of August 1948, based on figures released by the Bureau of Census, jumped 14 per cent to reach the highest production figure for glass containers in several months. Production has been dropping continuously since May 1948 and the increase of the August figure of 8,890,189 gross over the July figure of 7,784,960 gross is the first break in that time. Production during August 1947 was 9,476,209 gross, which is about 6 per cent above August this year. Glass container production for the January-August 1948 period has reached a total of 66,866,104 gross. At the close of the corresponding period in 1947 production had reached a total of 79,873,894 gross, which is about 16 per cent more than for this year.

Shipments of glass containers also spurted for the month of August 1948 after two or three months on the

### GLASS CONTAINER SHIPMENTS

(All figures in gross)

| | *August* 1948 |
|---|---|
| **Narrow Neck Containers** | |
| Foods | 1,089,084 |
| Medicinal & Health Supplies | 977,644 |
| Chemical, Household & Industrials | 522,349 |
| Beverages, Returnable | 576,258 |
| Beverages, Non-returnable | ..... |
| Beer, Returnable | 184,481 |
| Beer, Non-returnable | 381,796 |
| Liquors | 641,825 |
| Wines | 219,318 |
| Toiletries & Cosmetics | 436,320 |
| Sub-Total (Narrow) | 5,029,075 |
| **Wide Mouth Containers** | |
| Foods | 2,206,822 |
| Dairy Products | 268,257 |
| Home Canning | 264,623 |
| Medicinal & Health Supplies | 231,750 |
| Chemical, Household & Industrials | 81,238 |
| Toiletries & Cosmetics | 153,693 |
| Packers' Tumblers | 117,526 |
| Sub-Total (Wide) | 3,323,909 |
| Total Domestic | 8,352,984 |
| Export Shipments | 300,198 |
| Total Shipments | 8,653,182 |

### GLASS CONTAINER PRODUCTION AND INVENTORY

(All figures in gross)

| | | *Production August* 1948 | *Stocks August* 1948 |
|---|---|---|---|
| Foods; Medicinal & Health Supplies; Chemicals, Household, Industrials; Toiletries and Cosmetics | Narrow Neck | 3,258,701 | 3,466,742 |
| | Wide Mouth | 2,638,860 | 2,151,550 |
| Dairy Products | | 262,323 | 227,190 |
| Home Canning | | 251,877 | 409,598 |
| Beverages, Returnable | | 601,748 | 759,160 |
| Beverages, Non-returnable | | ..... | ..... |
| Beer, Returnable | | 278,446 | 832,906 |
| Beer, Non-returnable | | 453,191 | 353,625 |
| Liquors | | 796,253 | 375,955 |
| Wines | | 221,525 | 203,998 |
| Packers' Tumblers | | 127,265 | 90,469 |
| Total | | 8,890,189 | 8,871,193 |

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down-grade. August shipments were 8,653,182 gross, or about 10 per cent above the 7,803,461 gross shipped during July. Shipments during August 1947 were 9,200,486 gross, which is about 5 per cent above August this year. Total glass container shipments for the first eight months of 1948 have reached 65,295,340 gross, as compared with the 75,998,197 gross shipped during the same period in 1947. This represents a difference of about 14 per cent.

Stocks on hand at the close of August 1948 were 8,871,193 gross, as compared with 8,708,038 gross on hand at the end of July 1948. Stocks on hand at the close of August 1947 were 7,300,442 gross.

**Plate glass production** for the month of August 1948, according to the Hughes Statistical Bureau, has again broken all records to establish a new all-time high with a production figure of 24,475,403 sq. ft. This tops the previous all-time high of 24,207,601 sq. ft. set in June 1948. Production during July 1948 was 17,484,218 sq. ft., or 35 per cent below August. During August 1947, plate glass production was 21,401,330 sq. ft., which is about 14 per cent below August this year. Total plate glass production thus far this year is 177,647,623 sq. ft., which is about 4 per cent above the 169,540 sq. ft. produced during the corresponding period in 1947.

**Automatic tumbler production** jumped a little more than 14½ per cent for the month of August 1948 to reach a total of 4,926,939 dozens. The previous month's production figure had been 4,036,003 dozens. Production during August 1947 was 5,854,125 dozens. Shipments for August fell off 2½ per cent as compared with July. The August figure was 4,684,771 dozens; the July figure, 4,804,904 dozens. August 1947 shipments were 4,867,231 dozens. Stocks on hand at the close of August 1948 were 7,396,699 dozens, as compared with 7,506,877 at the close of July and 8,158,257 dozens at the close of August 1947.

**Table, kitchen and household glassware:** Manufacturers' sales of machine-made table, kitchen and household glassware for the month of August 1948 were 3,074,900 dozens. This is a little more than 3 per cent above the 2,977,409 dozens sold during July. Sales during August 1947 were 3,644,923 dozens. Total manufacturers' sales for the 12-month period ending August 1948 have reached a total of 42,953,341 dozens, as compared with 41,117,842 dozens at the close of the 12-month period ending August 1947.

Because of lateness, one company's figures are not included in the figures for automatic tumbler production and table, kitchen and household glassware. However, the totals for this company have been estimated for the compilation of the above figures and if you follow this department regularly, you will note that the figures are adjusted in the following issue when such an instance as this arises.

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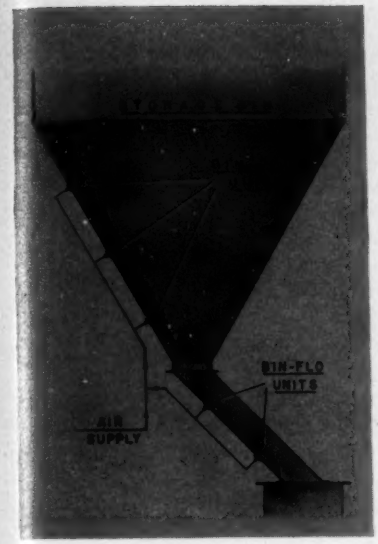
• The Foxboro Company is constructing a new building in Houston, Texas, which will become the Houston branch of the company's activities.

# NEW EQUIPMENT AND SUPPLIES




## BIN-DICATOR ANNOUNCES NEW AERATING DEVICE

The Bin-Dicator Company, Dept. D-407, 14615 E. Jefferson Avenue, Detroit 15, Michigan, has announced its Bin-Flo, a new aerating device to provide uniform and steady flow of bulk materials from bins, hoppers and chutes.

The new device provides a new and economical solution to the restriction and stoppage of bulk materials in bins and chutes, according to the company's annonucement. The unit is a small plate, 3¾" x 7½" x ½" thick, which is readily located at points where flow is restricted. Low-pressure air is injected into the material through a special fabric diffuser, causing the material to flow freely. The Bin-Flo units will not plug up even with the most finely ground material and are applicable to most dry, finely-ground materials, it is further stated.

The Bin-Flo models are provided for thin-walled bins and chutes and for concrete and other thick-walled hoppers. Piping can be run either outside of a thin-walled bin or inside of a thick-walled container.

## WINSMITH SPEED REDUCER

The Winfield H. Smith Corporation, Springville, Erie County, New York, is producing a new Winsmith Patented Helical Gear Differential Speed Reducer.

The new model retains all the advantages of previous models with the additional advantages of direct centered load distribution, more rigid and vibrationless mounting, larger area for heat radiation and increased quietness of operation.

Ratios from 5 to 1 to as much as 50,000 to 1 can be provided with no increase in number of parts. Horse power ranges from .62 to 81.5. Six sizes are available for every phase of industrial service. They are made in horizontal, vertical and flange-mounted styles.

## COMBINATION INDUSTRIAL TRUCK AND SCOOP

Elwell-Parker Electric Company, Cleveland, Ohio, has announced an electric power industrial truck equipped with a special type of scoop.

The scoop is attached to the truck's tilting and elevating mechanism and all controls are centralized at the driver's station. A simple tripping device on the scoop provides for rapid discharge of the load. It also has a pneumatic snubber to cushion impacts. When the scoop is lowered to floor level, it assumes its normal shoveling position.

Providing for ready adjustment to local conditions, the truck's upright column may be tilted forward 5 degrees from perpendicular. For safe carrying of the load and to avoid spillage, the upright column may be tilted backward 15 degrees perpendicular. The machine facilitates loading or emptying the scoop at floor levels or at any height up to 117 inches. Capacity area of the scoop is 12 cubic feet; capacity weight of load is 2000 pounds. Speed of the truck with load ranges up to 5½ miles an hour.

The combination of lift truck and scoop is especially adaptable in plants or areas where bulk materials are handled, such as related to glass, chemicals, sand, paints, cement, coal, etc.

## NEW LIGHT WEIGHT LIFT TRUCK

Transitier Truck Company, Portland, Oregon, has announced the manufacture of a gasoline powered fork lift truck which is now in large scale production.

Its 1000 and 2000 pound lift capacity makes possible high speed loading and unloading of highway transport trucks and railroad cars. The design of the lift truck features an all welded one-piece body frame construction of heavy gage steel stampings; four cylinder water cooled fabricated "Cobra" engine developing 26hp; 61" turning radius for maneuverability in narrow-aisle, congested warehouses; hydraulically operated lift and tilt of load-carrying mast; Hydroflex clutch which deviates entirely from the conventional by being located behind and above the engine for easy accessibility.

## DRAVO DEVELOPS AIR CONDITIONING UNIT

Dravo Corporation, Fifth and Liberty Avenues, Pittsburgh 22, Pa., has developed a small air conditioning unit designed to protect crane operators against the hazards of excessive heat, dust, fumes and noxious gases in factories or foundries, where glass, cement, paint, aluminum, copper, lead, manganese and magnesium are handled or produced.

Designed for operation in ambient temperatures up to 130°F., the new equipment will maintain cab temperatures at 80° to 85° in the summer and 68° to 72° in the winter. A vertical unit, it can be mounted alongside a crane cab or placed on adjoining catwalks. Only a power supply line is needed for its installation.

## CATALOGUES RECEIVED

*Leeds and Northrup Company*, 4934 Stenton Avenue, Philadelphia 44, Pa., has issued a revised catalogue titled, "L&N Electric Control, Position Adjusting Type."

The new 40-page catalogue is illustrated with pictures of actual installations, and shows how the P.A.T. system provides complete control adaptable to nearly any control problem. The system provides full proportional control action with automatic droop-correction, obtained through the use of the accurate balance method both for measurement and control. In addition to the well-known Micromax instruments, the publication also lists the Speedomax line of controllers for applications where unusual sensitivity and speed of response are required.

*Pittsburgh Corning Corporation* has issued a new four-page brochure on the use of Foamglas cellular glass insulation for low temperature work, including cold storage applications.

The brochure describes and illustrates Foamglas, lists various advantages, lists the properties, recommends thicknesses for low temperature and illustrates several installations.

*The Skybryte Company*, Cleveland, Ohio, is distributing an informative folder on Skybryte cleaning crystals for cleaning street lighting globes, glass, reflectors, porcelain skylights and factory windows.

The crystals dissolve readily and the solution is made when, where and in quantity needed. The folder gives prices and offers a sample upon request.

*The Robinson Air-Activated Conveyor Systems*, New York, New York, has published a bulletin which includes a cut-away view of the activator.

The bulletin lists typical materials conveyed, gives the physical range of materials handled and capacity of the activator. A line drawing illustrates a typical conveyor problem and the advantages of the system are given.

## GLASS BLOWING COURSE AT CITY COLLEGE OF NEW YORK

The manipulation of ready-made glass tubing, rods and bulbs from heat supplied by blast lamps will be studied and practiced in the "Glassblowing" course being offered by the Evening and Extension Division, City College School of Business, New York City.

Designed for chemistry students interested in making their own instruments, the course will include demonstrations and supervised practice periods. All phases in the fundamental techniques of shaping heated glass and the supplementary processes involved in finishing cold glass will be covered.

Students will be required to produce instruments used in chemical research such as medicine droppers, test tubes, condensers and distilling flasks. They will learn the methods of heating, drawing, pressing, flanging, trimming, bending, blowing, perforating, closing and welding heated and molten glass, and the techniques which apply to cold glass such as cutting tubing, squaring ends, cleaning, flaring, lipping or fluting, fire-polishing and point pulling.

## JAMES GILLINDER, PRESIDENT OF GILLINDER BROTHERS, DIES

It has been learned that James Gillinder, President of Gillinder Brothers, Inc., died at the University of Pennsylvania Hospital where he had recently gone for treatment.

Mr. Gillinder spent his entire life in the glassware industry. As a charter member of the American Glassware Association, he has served in many official capacities and, at the time of his death, was Chairman of the Association Tariff Committee.

He is survived by his widow, Irene Stafford Gillinder, and two daughters.

## N. Y. METROPOLITAN A.C.S. SECTION PLANS SEASON'S MEETINGS

The first meeting of the N. Y. Metropolitan Section of the American Ceramic Society will be held on October 20. Winston H. Duckworth, Battelle Memorial Institute, will be the speaker of the evening and his subject will be "Operational Characteristics and Design Features of Rockets and Jets Affecting the Selection of Construction Materials" and "Refractory Ceramic Body Developments." Under the latter half of his talk are the following headings: Oxide Systems, Metal-Ceramic Combinations, Graphite and Carbon, Intermetallic Compounds Including Silicon Carbide.

The second meeting will be held on January 19, 1949, and a speaker from E. I. du Pont de Nemours & Co. has been requested, the subject to be Colors and Decorations.

On March 16, the Section will present a pre-dinner talk by William Parrish, Research Physicist of Philips Laboratories, whose subject will be "Recent X-Ray Diffraction Developments of Interest to Ceramists." After dinner, J. H. Scaff, Bell Telephone Laboratories, will speak on Transistors.

The following meeting will be held on May 18 and a talk on "Organic Clay Compounds, Their Preparation and Use," will be given by Dr. F. J. Williams, National Lead Company.

## ANNUAL MEETING OF CZECHOSLOVAK CERAMIC AND GLASS SOCIETY

The annual meeting of the Czechoslovak Ceramic and Glass Society took place in the spaa of Karlova Studanka.

The further existence of the Glass Division was believed to depend on work performed by the Division in the interest of science and industry. For this purpose numerous technical commissions were nominated and elected, such as commissions on science, education, furnaces and plant construction, technology, methods, history and museology, standards. In contradistinction to American usage, a large number of commission members represent management, production and labor. The entire Division membership has reached 96.

Dr. Lewinter, general manager of the nationalized glass works, was elected president of the Ceramic and Glass Society as well as chairman of the Glass Division. Dr. Kallauner, of the Silicate Institute in Brne, spoke on quality in the ceramic industries. Mr. Olsewski reported on the glass industry in Poland.

## PITTSBURGH PLATE APPOINTMENT

The appointment of Robinson F. Barker as Assistant Manager of plate glass sales for Pittsburgh Plate Glass Company has been announced.

Prior to Mr. Barker's transfer to the firm's general offices in Pittsburgh, he had served as Manager of the Nashville, Tennessee, warehouse. During the war years, Mr. Barker had served forty-five months with the U. S. Navy, being discharged with the rank of Lieutenant.

A graduate of Harvard University in 1935, Mr. Barker has been associated with Pittsburgh Plate Glass Company since that time. Before the war, he was glass manager at the Baltimore, Maryland, warehouse. Previously he had been employed in various capacities in the company's glass factories and warehouses.

## POLISH GLASS PRODUCTION IN 1947 AND 1948

In 1948 the Polish glass industry plans* the manufacture of 150,000 metric tons of glass (1947: 136,000 tons; 1938: 113,000 tons).

The individual branches of production are represented as follows; Windows and plate, 58%; containers, 35%; scientific, 2%; and tableware, illum., etc., 5%.

The types of enterprise represented are as follows: 1) Operated by the Central Committee of Mineral Industries: 110,000 tons in 35 plants. 2) Other state institutions, cooperative and private owners: 40,000 tons in 35 plants.

This total of 70 plants compares to nearly 100 in 1938, although the production is higher.

The investments in 1948 will be 130,000,000 zloty of which 60% will be spent for the reconstruction of plants now not in operation. A large amount of the capital will be used for the increasing automatization of the bottle industry, the machines being AMCO and Roirant.

It is planned to export glass for $6,000,000 as compared to $3,000,000 in 1947.

*Condensed from the address of K. Olsewski before the Czechoslovak Ceramic and Glass Society, Sklarske Rozhl. *24* (2, 3) 21-22 (1948).

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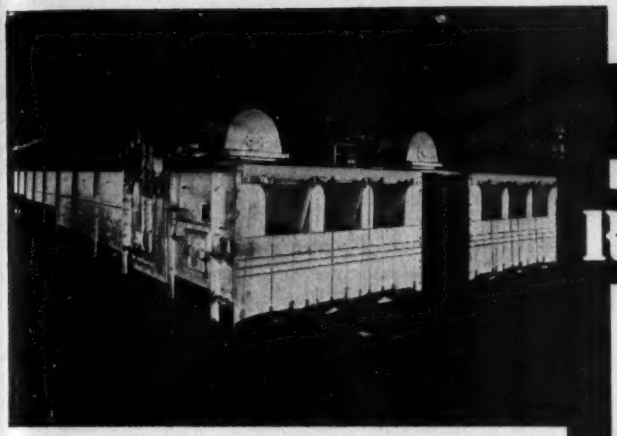

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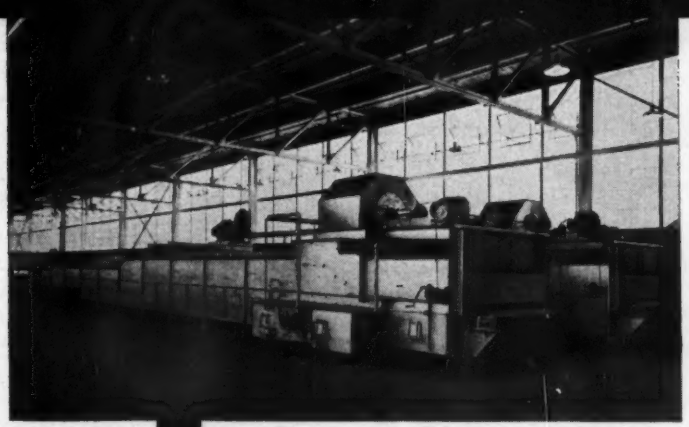

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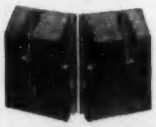

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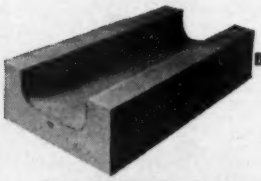

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## L-O-F MARKS ANNIVERSARY OF GROUND-BREAKING OF ORIGINAL COMPANY

Libbey-Owens-Ford Glass Company recently celebrated the fiftieth anniversary of the breaking of ground for the Edward Ford Plate Glass Company, the older of two companies to be merged in 1930 to form what is now the Libbey-Owens-Ford Glass Company.

Site of the ground-breaking was on a 175-acre farm along the Maumee River adjoining Toledo. The combination of fuel, raw materials and skilled craftsmen available in this region were factors which led to its selection.

Mr. Ford's father, Captain John B. Ford, was a pioneer plate glass manufacturer in America. He began plate glass manufacture in Indiana in 1868 and with his sons, Edward and Emory, developed glass interests in the East.

Fourteen months after the ground-breaking at Toledo, Mr. Ford made his first glass shipments from what was then and still is considered the largest individual plate glass plant in the United States. With improved processes for plate manufacture adopted from year to year and with resulting increased production and sales, the Ford plant grew steadily.

At the same time, the Libbey-Owens Sheet Glass Company was chartered in 1916. Prior to 1925, Libbey-Owens made nothing but window glass, but in that year they began to make plate glass because of the automotive demand. It was among the early makers of safety glass. Making extensive changes in its plant, the Ford company and the Libbey-Owens company felt that the two units would complement each other in the future development of safety glass and on July 1, 1930, the companies were brought together into the present Libbey-Owens-Ford Glass Company.

## NATIONALIZED CZECH GLASS INDUSTRY UNDER NEW MANAGEMENT

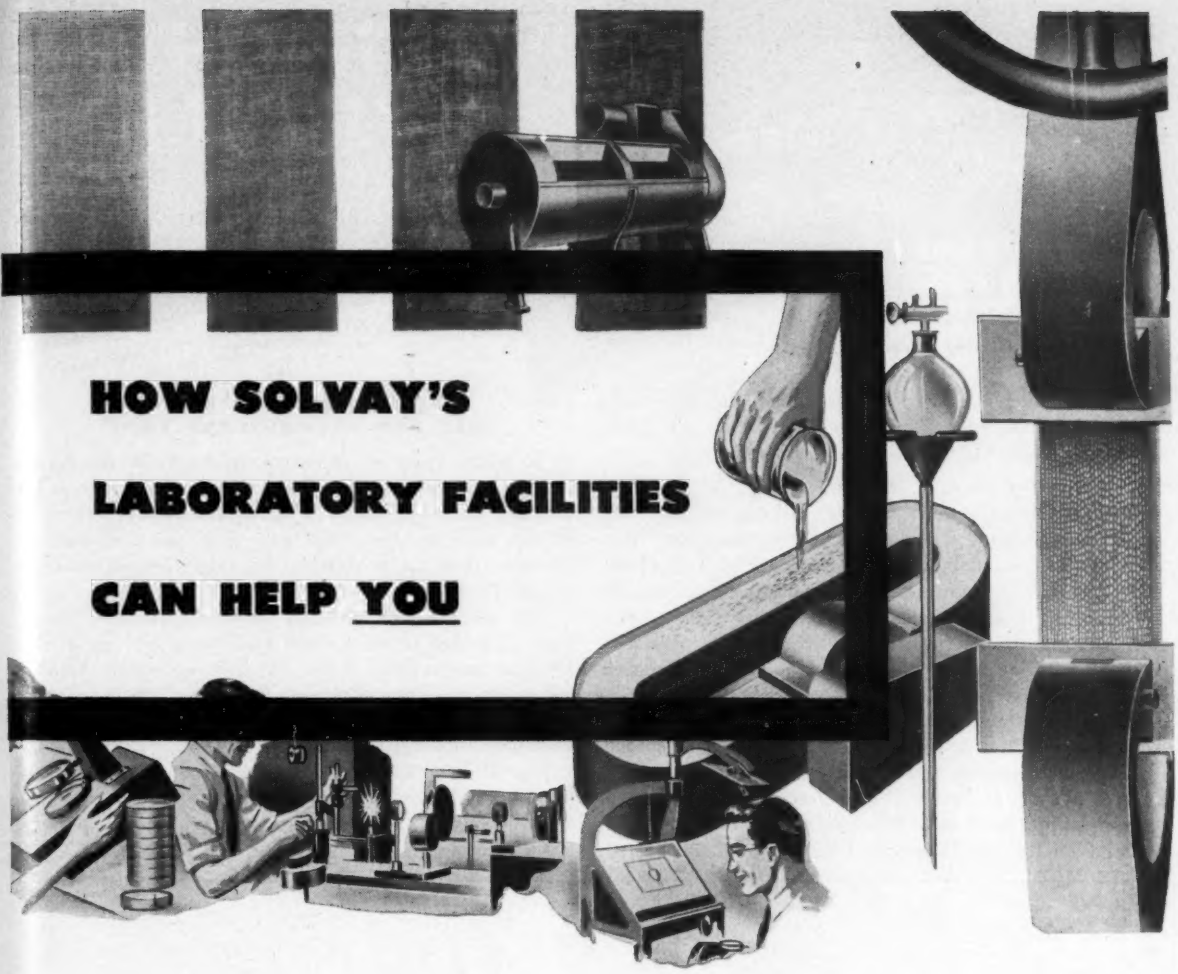
After the resignation of J. Hrnicko, Dr. M. Lewinter was appointed General Manager of the Czechoslovak Glass Works, National Corporation. The concern is the combine of the entire Czechoslovak glass industry which was organized after its nationalization. This change in office coincided with the change in national government.

## GLASS TECHNOLOGY PROGRAM AT TOLEDO UNIVERSITY ENTERS SECOND YEAR

The glass technology program at the University of Toledo is entering its second year with the opening of the current Fall term and increased student interest is expected.

Evening classes have been arranged in four beginning glass courses. The four-year course leads to the degree of Bachelor of Engineering. Because the first two years of the prescribed course are identical with Chemical Engineering, qualified students were able to start their junior year in Glass Technology in 1947 and will now enter their senior year to become candidates for the bachelor degree next Spring.

University authorities have arranged for evening courses in Minerology and Crystallography, Microscopic and X-ray studies, Glass Technology I and Glass Manufacture. These courses are open to part-time as well as regular students.



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**INVENTIONS AND INVENTORS . . .**

(*Continued from page* 572)

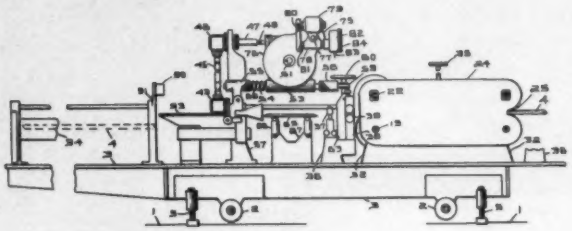

**Fig. 10. Tube Cutting Machine.**

1,730,926, Fitch, Oct. 8, 1929; 1,914,205, Hooper et al., June 13, 1933; and 2,266,417, Eisler, Dec. 16, 1941. Foreign Patents: 13,609, Germany, June 9, 1881.

*Tube Cutting Machine. Fig. 10. Patent No. 2,447,962.* Franz G. Schwalbe invented this machine and assigned it to his company, Toledo Engineering Company, Inc. The machine is adapted to cut any kind of cylindrical glass such as thermometer tubing cane and products of that kind, into uniform lengths as the glass comes from the forming machine which might be, for example, a Danner machine. The rate of production on machines of that type may be as high as 350 feet per minute.

The figure shows a machine movable on wheels 2 so that it can be put in proper position in front of a tube drawing machine, to receive the tube 4. The truck 3 carries a variable speed electric motor which drives a tube gripping device which can be adjusted by the hand wheel 35. Rollers 39 pass the tube toward the cut-off mechanism where the tube is cut to the desired lengths by a cutter disk 83 driven by a motor 79. The severed tube is delivered to a receiving chute 94.

The following references are of record in the file of this patent: United States Patents: 1,220,201, Danner, Mar. 27, 1917; 1,242,478, Rosewarne, Oct. 9, 1917; 1,585,896, Danner, May 25, 1926; 1,647,352, Halstead, Nov. 1, 1927; 1,868,397, Salomon, July 19, 1932; 2,290,837, Stuckert, July 21, 1942; 2,306,721, Forter et al., Dec. 29, 1942; and 2,332,013, Rudert et al., Oct. 19, 1943.

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## WESTINGHOUSE USES RARE GAS FOR FLUORESCENT LAMP

After many years of experimental work, Westinghouse Lamp Division has announced the use of Krypton in its recently developed 85-watt fluorescent lamp. The use of this rare gas gives the lamp a 17 per cent gain in efficiency over the generally used argon gas, it has been reported.

The new 85-watt, 60-inch long, 2⅛ inch diameter lamp provides as much light and burns as long as the 100-watt argon-filled lamp which it replaces. According to the company's report, this reduction in wattage means that users can save 17 per cent on their electricity costs without lowering their light levels.

The 85-watt Krypton lamps have the same dimensions and electrical characteristics as the 100-watt fluorescent lamps and can, therefore, be used in present 100-watt fixtures.

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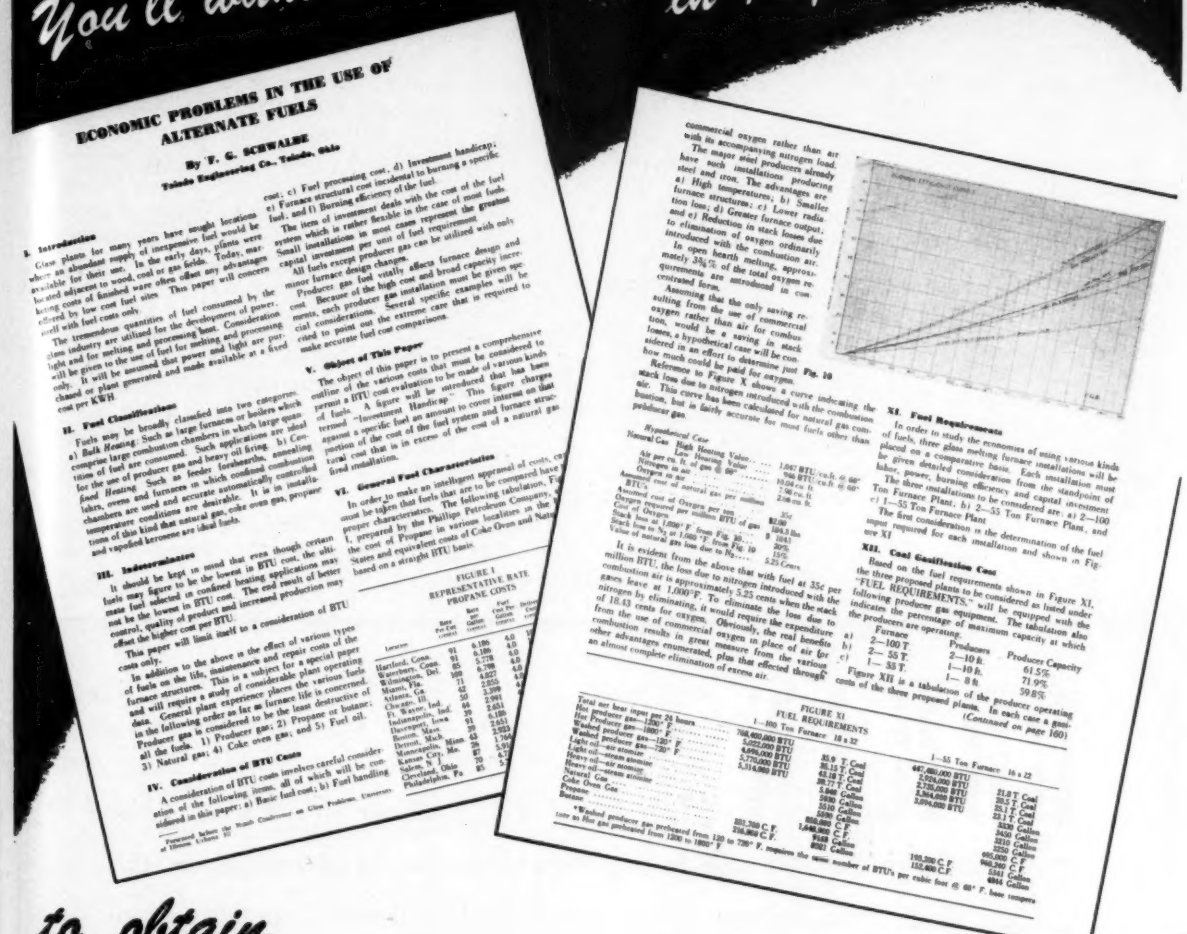

ECONOMIC PROBLEMS IN THE USE OF ALTERNATE FUELS

By F. G. SCHWALBE

Toledo Engineering Co., Toledo, Ohio

I. Introduction

Glass plants for many years have sought locations where an abundant supply of inexpensive fuel would be available for their use. In the early days, plants were located adjacent to wood, coal or gas fields. Today, manufacturing costs of finished ware often offset any advantages offered by low cost fuel sites. This paper will concern itself with fuel costs only.

The tremendous quantities of fuel consumed by the glass industry are utilized for the development of power. Light and for melting and processing. Consideration will be given to the use of fuel for melting and light are purely. It will be assumed that power and light are purchased or plant generated and made available at a fixed cost per KWH.

II. Fuel Classification

Fuels may be broadly classified into two categories. a) *Bulk Heating*: Such as large furnaces or boilers which comprise large combustion chambers in which large quantities of fuel are consumed. Such applications are ideal for the use of producer gas and heavy oil firing. b) *Controlled Heating*: Such as feeder forehearths, annealing lehrs, ovens and forms in which combined combustion chambers are used and accurate automatically controlled temperature conditions are desirable. It is in installations of this kind that natural gas, coke oven gas, propane and vaporized kerosene are ideal fuels.

III. Indeterminates

It should be kept in mind that even though certain fuels may figure to be the lowest in BTU cost, the ultimate fuel selected in confined heating applications may not be the lowest in BTU cost. The end result of better control, quality of product and increased production may offset the higher cost per BTU.

This paper will limit itself to a consideration of BTU costs only.

In addition to the above is the effect of various types of fuels on the life, maintenance and repair costs of the furnace structures. This is a subject for a special paper and will require a study of considerable plant operating data. General plant experience places the various fuels in the following order as far as furnace life is concerned. Producer gas is considered to be the least destructive of all the fuels. 1) Producer gas; 2) Propane or butane; 3) Natural gas; 4) Coke oven gas; and 5) Fuel oil.

IV. Consideration of BTU Costs

A consideration of BTU costs involves careful consideration of the following items, all of which will be considered in this paper: a) Basic fuel cost; b) Fuel handling cost; c) Fuel processing cost; d) Investment handicap; e) Furnace structural cost incidental to burning a specific fuel; and f) Burning efficiency of the fuel.

The item of investment deals with the cost of the fuel system which is rather flexible in the case of most fuels. Small installations per unit of fuel requirement. Capital investment per unit of fuel required.

All fuels except producer gas can be utilized with only minor furnace design changes.

Producer gas fuel vitally affects furnace design and cost. Because of the high cost and broad capacity increments, each producer gas installation must be given special consideration. Several specific examples will be cited to point out the extreme care that is required to make accurate fuel cost comparisons.

V. Object of This Paper

The object of this paper is to present a comprehensive outline of the various costs that must be considered to permit a BTU cost evaluation to be made of various kinds of fuels. A figure will be introduced that has been termed "Investment Handicap". This figure charges against a specific fuel an amount to cover interest on that portion of the cost of the fuel system and furnace structural cost that is in excess of the cost of a natural gas fired installation.

VI. General Fuel Characteristics

In order to make an intelligent appraisal of costs, comparisons must be taken that fuels that are to be compared have proper characteristics. The following tabulation, Figure I, prepared by the Phillips Petroleum Company, shows the cost of Propane in various localities in the United States and equivalent costs of Coke Oven and Natural gas on a straight BTU basis.

FIGURE I
REPRESENTATIVE RATE
PROPANE COSTS

| Location | Rate Per Gal. Cents | Rate per 1000 Cubic Feet | Fuel Cost per Gallon Cents | Fuel Cost per 1000 Cubic Feet |
|---|---|---|---|---|
| Hartford, Conn. | 91 | 6.186 | 4.0 | 272 |
| Worcester, Conn. | 85 | 5.778 | 4.0 | 272 |
| Wilmington, Del. | 169 | 4.827 | 4.0 | 272 |
| Miami, Fla. | 71 | 4.827 | 4.0 | 272 |
| Atlanta, Ga. | 42 | 2.856 | 4.0 | 272 |
| Chicago, Ill. | 58 | 3.944 | 4.0 | 272 |
| Ft. Wayne, Ind. | 44 | 2.991 | 4.0 | 272 |
| Indianapolis, Ind. | 58 | 3.944 | 4.0 | 272 |
| Davenport, Iowa | 57 | 3.876 | 4.0 | 272 |
| Boston, Mass. | 69 | 4.691 | 4.0 | 272 |
| Detroit, Mich. | 63 | 4.284 | 4.0 | 272 |
| Minneapolis, Minn. | 87 | 5.916 | 4.0 | 272 |
| Kansas City, Mo. | 49 | 3.332 | 4.0 | 272 |
| Salem, N. Dak. | 70 | 4.760 | 4.0 | 272 |
| Cleveland, Ohio | 85 | 5.780 | 4.0 | 272 |
| Philadelphia, Pa. | 85 | 5.780 | 4.0 | 272 |

commercial oxygen rather than air with its accompanying nitrogen load. The major steel producers already have such installations producing steel and iron. The advantages are: a) High temperatures; b) Smaller furnace structures; c) Lower radiation loss; d) Greater furnace output, and e) Reduction in stack losses due to elimination of oxygen ordinarily introduced with the combustion air.

In open hearth melting, approximately 38% of the total oxygen requirements are introduced in combustion air.

Assuming that the only saving resulting from the use of commercial oxygen rather than air for combustion, would be a saving in stack losses, a hypothetical case will be considered in an effort to determine just how much could be paid for oxygen.

Reference to Figure X shows a curve indicating the stack loss due to nitrogen introduced with the combustion air. This curve has been calculated for natural gas combustion, but is fairly accurate for most fuels other than producer gas.



Fig. 10

Hypothetical Case

| Natural Gas | High Heating Value | Low Heating Value |
|---|---|---|
| Air per cu. ft. of gas @ 60° | 1,047 BTU | 944 BTU |
| Nitrogen in air @ 60° | 9.86 cu. ft. | 9.86 cu. ft. |
| Oxygen in air | 2.08 cu. ft. | 2.08 cu. ft. |

BTU of natural gas per [illegible] 35¢

Assumed cost of Oxygen per ton $2.00

Oxygen required per million BTU of gas 184.3 lbs

Cost of Oxygen per million BTU $ 1041

Stack loss at 1,000° F from Fig. 10 20%

Stack loss at 1,000° F from Fig. 10 [illegible]%

Value of natural gas lost due to N2 5.25 Cents

It is evident from the above that with fuel at 35¢ per million BTU, the loss due to nitrogen introduced with the combustion air is approximately 5.25 cents when the stack gases leave at 1,000° F. To eliminate the loss due to nitrogen by eliminating, it would require the expenditure of 18.83 cents for oxygen. Obviously, the real benefits from the use of commercial oxygen in place of air for combustion results in great measure from the various other advantages enumerated, plus that effected through an almost complete elimination of excess air.

XI. Fuel Requirements

In order to study the economies of using various kinds of fuels, three glass melting furnace installations will be placed on a comparative basis. Each installation must be given detailed consideration from the standpoint of labor, power, burning efficiency and capital investment.

The three installations to be considered are: a) 2—100 Ton Furnace Plant; b) 2—55 Ton Furnace Plant, and c) 1—55 Ton Furnace Plant.

The first consideration is the determination of the fuel input required for each installation and shown in Figure XI.

XII. Coal Gasification Cost

Based on the fuel requirements shown in Figure XI, the three proposed plants to be considered as listed under "FUEL REQUIREMENTS," will be equipped with the following producer gas equipment. The tabulation also indicates the percentage of maximum capacity at which the producers are operating.

| | Furnaces | Producers | Producer Capacity |
|---|---|---|---|
| a) | 2—100 T. | 2—10 ft. | 61.5% |
| b) | 2— 55 T. | 2—10 ft. | 71.9% |
| c) | 1— 55 T. | 1—10 ft. | 59.8% |

Figure XII is a tabulation of the producer operating costs of the three proposed plants. In each case a gasi-

(Continued on page 160)

FIGURE XI
FUEL REQUIREMENTS

| | 1—100 Ton Furnace 18 x 32 | | 1—55 Ton Furnace 16 x 22 | |
|---|---|---|---|---|
| Total net heat input per 24 hours | 768,400,000 BTU | | 447,480,000 BTU | |
| Hot Producer gas—1200° F. | 5,022,000 BTU | 35.9 T. Coal | 2,926,000 BTU | 21.0 T. Coal |
| Washed producer gas—100° F. | 4,696,000 BTU | 35.1 T. Coal | 2,736,000 BTU | 20.5 T. Coal |
| Washed producer gas—120° F. | 5,770,000 BTU | 43.1 T. Coal | 3,360,000 BTU | 25.1 T. Coal |
| Light oil—steam atomizing | 1,314,000 BTU | 81.9 T. Coal | 1,844,000 BTU | 23.1 T. Coal |
| Light oil—air atomizing | | 3,868 Gallons | 5,094,000 BTU | 3220 Gallons |
| Heavy oil—steam atomizing | | 3030 Gallons | | 3410 Gallons |
| Heavy oil—air atomizing | | 3030 Gallons | | 3210 Gallons |
| Natural Gas—steam atomizing | | 808,000 C.F. | | 3250 Gallons |
| Coke Oven Gas | | 1,646,000 C.F. | | 3430 Gallons |
| Propane | | 1,648 Gallons | | 1610 Gallons |
| Butane | | 1,648 Gallons | | 1610 Gallons |
| | 201,200 C.F. | 8081 Gallons | 105,200 C.F. | 685,000 C.F. |
| | 256,000 C.F. | | 132,400 C.F. | 960,200 C.F. |
| | | | | 5541 Gallons |
| | | | | 4844 Gallons |

*Washed producer gas preheated from 120° to 720° F. requires the same number of BTU's per cubic foot @ 60° F. base temperature as Hot gas preheated from 1200° to 1800° F.

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### ALAMO TAN, NEW COLOR FOR STRUCTURAL GLASS

A new shade of structural glass, known as Alamo Tan, has gone into production to replace Ivory Vitrolite which no longer can be made because of the ban on the use of uranium, according to C. Edward Johnson, Manager of Vitrolite sales for Libbey-Owens-Ford Glass Company.

Before the war, uranium compound was used as a constituent of the batch for manufacture of the ivory colored Vitrolite. However, since the beginning of the war, the company has used no uranium, turning its supply over to the government.

Alamo Tan is a very warm, rich, light color that will be particularly suitable for bathrooms and kitchens in the home and for walls in public buildings and store facades. The new color, which was designed for color coordination by interior decorators, will be available in fire polished and mechanically polished surfaces.

### CAMBRIDGE WIRE CLOTH ANNOUNCEMENTS

The Cambridge Wire Cloth Company has announced the appointment of Paul V. Thomure as District Sales Engineer for the company's St. Louis office. Mr. Thomure will cover the states of Missouri, southern Illinois, southern Indiana, Kentucky and Tennessee.

At the same time it was announced that the company has opened a sales office in Houston, Texas. District sales engineer in charge of the new operation is Charles E. Shuman. The territory covered by the new office will include Texas, Oklahoma, Arkansas, Louisiana and Mexico.

### REPORT ON PROPOSED DEFINITIONS PERTAINING TO SHIPPING CONTAINERS

A.S.T.M. Committee D-10 on Shipping Containers has been working for many months on proposed definitions for a large number of terms pertaining to shipping containers and related items.

The new definitions, carrying a designation D 996, cover more than 100 terms, such as bag, barrel, basket, can, carton. Various types of containers, such as glass, wood framed, etc.; common type hamper and various types of nails, stripping, wadding and the like are covered.

Some of the definitions seem relatively concise. "Box," for example, is described as "A rigid container having closed faces." A description of a hamper is somewhat more lengthy reading "A container (commonly used for shipping fruits and vegetables) circular, elliptical or polygonal in horizontal cross section, the top dimensions being usually greater than the bottom. It has slatted sides and a bottom which may be loose, stapled or nailed in place. The top may or may not be open."

### CZECHOSLOVAK GLASS INSTITUTE HAS NEW DIRECTOR

Dr. M. Fanderlik succeeded Dr. V. Ctyroky as Director of the Glass Institute in Hradec Kralove, Czechoslovakia. Dr. Fanderlik is one of the forement glass scientists in Czechoslovakia.

The resignation of Dr. Ctyroky took place during the recent change in government and no appointment of Dr. Ctyroky to another position has been announced.


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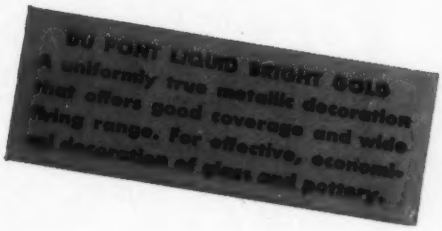
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(*Continued from page* 567)

sticking (graphite slabs can also be used). As the cubes become heated they are gradually moved into hotter zones and, finally, to the paddling zone. Here they are paddled into shape by means of iron rods flattened at the ends.

Care must be exercised not to work into the glass the material that dusts off the floor slabs. Folds may be introduced during paddling unless extreme care is taken. When the glass has attained the shape to fit in the mold and the proper consistency, it is pulled into the preheated mold and pressed. The blank is removed from the mold and placed in an oven on top of the furnace where it slowly cools. For the larger blanks in this category, a separate preheating furnace and cooling oven may be necessary.

b) Intermediate blanks (approximately 0.25 to 5 pounds), Punty rod. For this method of molding, the glass must be heated until it will adhere to the punty head. Experiments indicated that a rate up to 6° C/minute was safe for heating glass; therefore, a rate of 4° C/minute was selected as having an ample factor of safety in designing preheating furnaces. These furnaces are built of low temperature insulating brick, except the trough in which the pans for holding the glass slide and the walls adjacent to the burners which are built of refractory brick. They are heated by two refractory screen burners, one on either side near the exit, operating on gas from a zero governor and low pressure air. A thermocouple for regulating each furnace projects through the crown at the hot end. Table 4 gives the preheating temperatures used for typical glasses.

The molding furnace (or glory hole) is of the drum

TABLE 4.

TEMPERATURES OF THE HOT ZONES OF PREHEATING FURNACES AND COOLING LEHRS USED FOR MOLDING OPTICAL GLASS BY THE PUNTY METHOD

| Type of glass | Hot zone temperatures (°C) | |
|---|---|---|
| | Preheating furnace | Cooling lehr |
| F 5795/410 | 610 | 500 |
| F 605/381 | 550 | 470 |
| F 617/366 | 540 | 440 |
| F 620/362 | 530 | 450 |
| F 649/338 | 550 | 475 |
| F 720/293 | 575 | 485 |
| BSC 517/645 | 690 | 575 |
| BaC 5725/574 | 700 | 575 |
| BaC 611/588 | 760 | 625 |
| LC 523/586 | 650 | 550 |
| BF 604/435 | 700 | 575 |

type with the upper portion lined with 4½ inches of insulating firebrick and the bottom lined with a preshaped, prefired plastic fire-clay refractory. This bottom tapers up from the center toward each end and has a drain hole at the low point. The temperature ranges from 1375° to 1400° C and is obtained by means of a refractory screen

* At the start of the war the punty heads were made of fired sections, cut from an extruded clay cylinder, cemented to the punty rod. Four to six of these heads might be broken per 8 hour shift. L. H. Maxwell suggested a welded steel head. This was tried and has been used with success ever since. Before use the head is given a coating of glass.

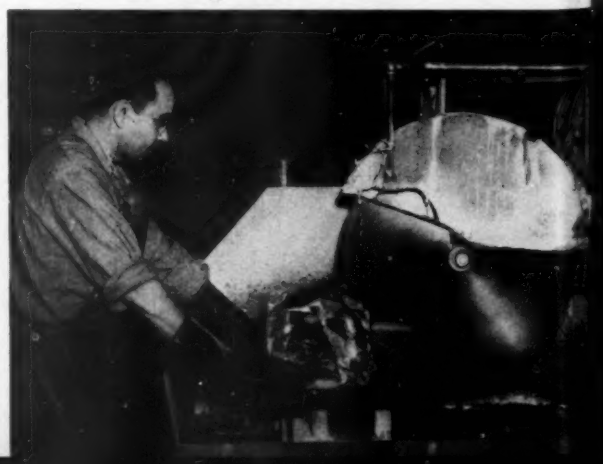
**Fig. 9. "Cutting off" a gob of hot, semifluid glass into a steel mold preparatory to pressing into shape.**

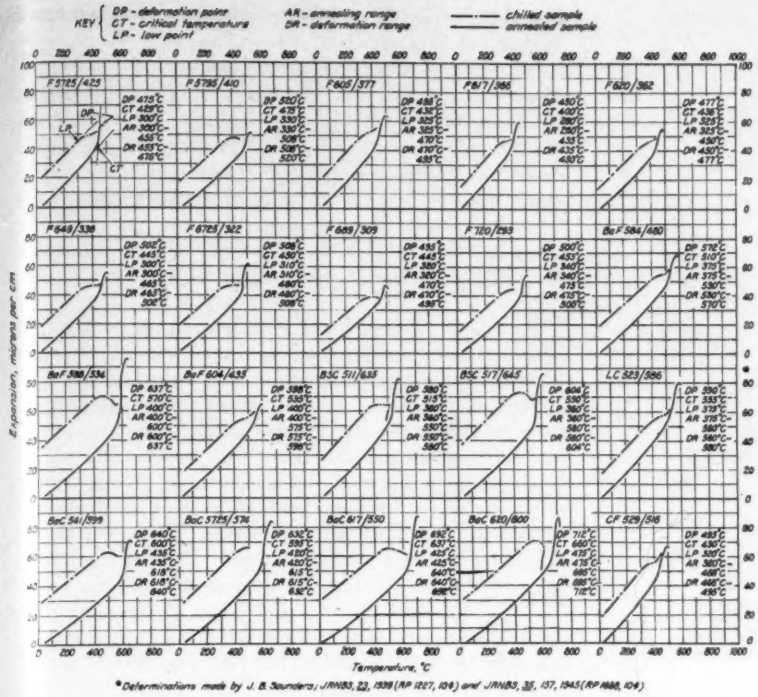
burner entering the furnace tangentially at the top. This arrangement gives a swirling flame and holds it until combustion is complete. Provisions are made to vary the furnace atmosphere from oxidizing to reducing.

The rough pieces of glass are cleaned and placed on shallow iron pans for introduction into the preheating furnace. When the glass has reached the working end of the preheating furnace, it will adhere to a punty.* A piece of glass is picked up on the end of a punty and transferred to the molding furnace. The glass is alternately heated and marvered to shape. During this operation sharp edges are trimmed and imperfections, such as seeds, folds, feathers, etc., that appear near the surface are cut out with shears. When the glass reaches the consistency and shape for pressing, it is suspended over the heated mold (400° to 500° C) and the amount necessary to make the blank is cut off with shears. The surface of the glass is heated under a burner to remove the shear marks caused by chilling and the gob is pressed into shape (Fig. 9).

Surface defects attributable to operating conditions during molding are of at least four types: 1. Devitrification (barium crowns), 2. Surface reduction (flints), 3. Surface seeds (barium flints), 4. A "web" defect which is normally visible only when the glass is immersed in a

**Fig. 10. Trimming a chunk of optical glass, with a 24-inch diamond saw, prior to slumping.**






*Determinations made by J. B. Saunders; JRNBS, 23, 1939 (RP 1227, 104) and JRNBS, 35, 157, 1945 (RP 1688, 104)

**Fig. 11. Expansion curves for some optical glasses as determined with the interferometer.**

liquid of equal index of refraction (flints 617/366, 620/362 and 649/338 and others; also, at times, borosilicate and barium crown glasses). These defects are objectionable mainly because they interfere with the inspection of the blanks.

The molds are made in three parts: the plunger, the frame and the base. The thickness of the blank can be changed by the use of washers between the frame and the base. The molds are rather massive so that they will have sufficient heat capacity to maintain an even temperature while in use. Cold-rolled steel and cast iron are satisfactory for molds.

The pressed blank is transferred to the lehr where it is placed on a pan lined with sheet asbestos. The electrically heated lehr is 30 feet long, with the hottest zone in the first four feet. The rate of travel can be varied from 3¾ feet/hour to 5 feet/hour (6-8 hours in the lehr). Table 4 gives the hot zone temperatures used for some of the glasses in the cooling lehrs.

c) Large blanks (over five pounds), Slumping. Large blanks are slumped in ceramic molds that are prepared for use by dusting or spraying, with a mixture of 95 per cent of powdered flint and five per cent of clay, which prevents the glass from sticking. The rough glass is trimmed to the proper weight with a diamond saw (Figure 10) and placed in the mold. The preheating end of a combination slumping-preheating furnace is filled with the molds and then gradually heated up to that temperature at which the glass flows freely and accurately assumes the contour of the mold. The molds are then moved into the cooler end of the furnace where the glass is annealed.

*8. Inspection of molded blanks.* Blanks are first inspected for seed and those containing too many or too large seeds are rejected; the remainder are inspected for striae. This inspection for striae is made in a tank having glass windows in the ends. The tank is filled with a liquid having an index of refraction similar to that of the glass to be inspected. The blanks are immersed in the liquid and, under proper illumination, imperfections in the glass become visible. A liquid which evaporates from the glass without leaving a residue is desirable since it makes unnecessary any cleaning operations. The optical system is essentially that reported by L. E. Dodd[8] entitled "(c) Modified Tank Immersion Method, Bureau of Standards." The immersion liquids must be clear and practically colorless. Three such liquids are used at this Bureau: (1) kerosens ($\eta = 1.45$), (2) monochlorbenzene ($\eta = 1.52$, and (3) carbon disulfide ($\eta = 1.62+$). These liquids are mixed in the proportions required to give the desired index. Caution must be exercised in the handling of carbon disulfide because of the extreme fire hazard. Alpha-monochlornaphthalene ($\eta = 1.633+$) can replace it and has the advantage of reducing the fire hazard. However, it presents a health hazard, inflicting some workers with a very painful rash. For indices above 1.62+, flowers of sulfur dissolved in carbon disulfide can be used. Inspection tanks are placed in hoods exhausted from the bottom. The exhaust fan is of sufficient capacity to maintain the concentration of vapors in the inspection room below that which would be injurious to health.

*9. Annealing.* Schedules for annealing, as given in Table 5, were devised with reasonable accuracy from the information obtained by the interferometer method of

**Fig. 12. Loading the steel box with molded blanks in preparation for annealing.**

TABLE 5. ANNEALING FURNACE SCHEDULES FOR OPTICAL GLASS BLANKS.

| Type of Glass | Flints 605/381, 617/366, 620/362, 720/293 and 754/277 | | Flints 649/338, 666/324 and 689/309. (Can also be used for Flints 620/362, 720/293 and 754/277) | | Flints 6725/322 and 5795/410 | | Borosilicate Crown 511/635, Light Crowns 512/605, and 523/586, and Barium Flints 584/460 and 604/435 | | Borosilicate Crowns 517/645 | | Barium Crowns 541/599, 5725/574 and 574/577, and Barium Flint 588/534 | | Barium Crowns 611/588 and 617/550 | | Barium Crown 620/600 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temperature or range | Cooling rate | Temperature or range | Cooling rate | Temperature or range | Cooling rate | Temperature or range | Cooling rate | Temperature or range | Cooling rate | Temperature or range | Cooling rate | Temperature or range | Cooling rate | Temperature or range | Cooling rate |
| | °C | °C/hr | °C | °C/hr | °C | °C/hr | °C | °C/hr | °C | °C/hr | °C | °C/hr | °C | °C/hr | °C | °C/hr |
| Hold 2 hours after[1] temperature reaches | 410 | — | 420 | — | 465 | — | 510 | — | 550 | — | 570 | — | 605 | — | 655 | — |
| Cool | — | — | — | — | 465–450 | 3.0 | 510–490 | 3.0 | 550–515 | 3.0 | 570–530 | 3.0 | 605–550 | 3.0 | — | — |
| Hold 12 hours at | — | — | — | — | 450 | — | 490 | — | 515 | — | 530 | — | 550 | — | — | — |
| Cool as follows | 410–390 | 0.75 | 420–410 | 0.75 | 450–430 | 0.75 | 490–465 | 1.0 | 515–500 | 1.0 | 530–510 | 1.0 | 550–525 | 1.0 | 655–620 | 1.0 |
| | 390–370 | 1.25 | 410–390 | 1.25 | 430–410 | 1.25 | 465–440 | 1.5 | 500–475 | 1.5 | 510–490 | 1.5 | 525–500 | 1.5 | 620–580 | 1.5 |
| | 370–350 | 1.75 | 390–370 | 1.75 | 410–390 | 1.75 | 440–420 | 2.0 | 475–450 | 2.0 | 490–470 | 2.0 | 500–475 | 2.0 | 580–520 | 2.5 |
| | 350–330 | 2.25 | 370–350 | 2.25 | 390–380 | 2.5 | 420–400 | 2.5 | 450–425 | 3.0 | 470–450 | 2.5 | 475–450 | 2.5 | 520–400 | 3.5 |
| | 330–300 | 3.0 | 350–325 | 3.0 | 380–340 | 4.0 | 400–360 | 4.0 | 425–400 | 4.0 | 450–410 | 4.0 | 450–410 | 4.0 | | |
| | 300 | — | 325 | — | 340 | — | 360 | — | 400 | — | 410 | — | 410 | — | 400 | — |
| Current off at | 300 | — | 300 | — | 300 | — | 340 | — | 350 | — | 375 | — | 375 | — | 375 | — |
| Raise top ¼ inch at | 275 | — | 250 | — | 275 | — | 300 | — | 300 | — | 325 | — | 350 | — | 325 | — |
| Remove top at | 225 | — | 250 | — | 275 | — | 300 | — | 200 | — | 325 | — | 350 | — | 325 | — |
| Steel box removed at | 225 | — | 250 | — | 275 | — | 300 | — | 200 | — | 325 | — | 350 | — | 325 | — |

[1] Top temperature in no case should exceed the maximum holding temperature by more than 5°C or the glass may slump.
NOTE: Heating the annealing furnace up to temperature for blanks five pounds or under takes 10-12 hours. For blanks over five pounds, the heating-up, holding and cooling-down schedules would have to be proportionately lengthened.

measuring thermal expansion[9] and from the work of Adams and Williamson[10]. Typical expansion curves for optical glasses are given in Figure 11. The annealing range lies between the low point (the temperature at which the release of strain in a chilled specimen starts) and the deformation point. Mechanical strain is released almost instantaneously in the rapid expansion range which lies between the critical temperature and the deformation point. Glass annealed in the rapid expansion range and cooled at a moderate rate will approximate the index of refraction obtained at the critical temperature.

In the annealing of glass another compromise must be made. The higher the temperature of annealing, especially for large blanks, the more slowly the furnace must be cooled at the start of the cooling cycle so as not to introduce strain in the blanks because of temperature gradients. Consequently, the glass is generally maintained at a fairly high temperature to release strain rather quickly and then held at a lower temperature within the annealing range to obtain the maximum index of refraction practicable (equilibrium at this lower temperature.)[11]. During this period any stresses introduced during cooling from the higher temperature are also released. The index of refraction obtained is somewhat higher than it would be had the glass been annealed at the higher temperature.

The glass blanks for annealing are placed on perforated steel trays. These trays are placed in a steel box (Figure 12) and separated from each other by spacers. The filled and covered box is placed in an electrically heated annealing furnace built of insulating firebrick. The top of the furnace is removable as a unit. The top is sealed to the body of the furnace by strands of asbestos tape.

These box-type annealing furnaces are heated by 19 resistance plates, three each on the sides and top, and four on the bottom. These plates are 14 by 9 inches, 220 volt, and are connected in series-parallel for uniform heating. The total current is controlled by variable autotransformers. A portion of the total current is bypassed through an external resistance and controller-operated relay. This differential current is set so that the current applied to the furnace with the relay open is approximately 3 to 5 amperes less than the total current. Thus the furnace is manually regulated but automatically controlled at any chosen temperature.

Small blanks are annealed in a furnace equipped with a program controller. Temperatures throughout the furnace are equalized by circulating the hot air with a motor-driven fan. A potentiometer recorder furnishes a visual record of the furnace operation. The annealing cycle with this equipment is somewhat shorter than that of the box-type furnace because of the equalized temperatures.

There is considerable latitude in the exact annealing schedule that may be used with satisfactory results. Uniformity of temperature within the furnace, however, is very important and is sometimes difficult to obtain. A low value of birefringence does not assure satisfactory annealing because index gradients, arising from differences in effective annealing temperatures within the glass, may be present.

Finally, the blanks are examined for strain under po-

(*Continued on page* 590)

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## OPTICAL GLASS AT THE NATIONAL BUREAU OF STANDARDS . . .

(*Continued from page* 588)

larized light while immersed in a liquid of index of refraction similar to the glass. If the glass is perfectly annealed, the area of the glass appears the same as the adjoining background; if not, an interference figure is obtained. This figure should show uniform distribution of residual strain and, when compared with standard strain samples, should indicate a relative retardation of 5 millimicrons or less per centimeter of transmitted path although the Joint Army-Navy Specifications allow a relative retardation of 10 millimicrons[12]. Blanks failing to pass the inspection for strain must be reannealed.

### III. General Remarks

Previous to 1939, the Bureau supplied the Navy with five types of optical glass: BSC 517/645, BaC 574/577, LC 523/586, F 620/362, and F 649/338. During World War II the Bureau supplied to the services 28 different types of optical glass. Also, the specifications for the blanks became ever more stringent. At present there are a number of additional types under laboratory experimentation. But taking a glass composition out of the laboratory and putting it into regular production is fraught with many difficulties.

The optical glass, to be acceptable, must at least pass the Joint Army-Navy Specifications[12]; the Navy at times requires glass of even higher quality. The index of refraction tolerance for glass of an index less than 1.56 is $\pm 0.001$; for those above 1.56 it is $\pm 0.0015$. The nu-value tolerance for those above 58.0 is $\pm 0.5$, except for LC 523/586, where it is $\pm 0.4$. Between 50.0 and 58.0, the nu-value tolerance is $\pm 0.4$; below 50.0 it is $\pm 0.3$. Also, the blanks from which reticles and elements in the focal plane are made must be free from bubbles or seeds over 0.0004 inch (0.01 mm) in diameter. For other purposes, a few larger seeds are permissible. Simply because they spoil the appearance of the polished element the seed limits are often more stringent than is really necessary for optical purposes.

The present trend in optical glass seems to be toward crowns of ever higher index of refraction and lower dispersion. And, as a corollary, optical designers would like to have high index flints with both higher and lower dispersions than can be obtained with the present flint compositions.

Filters of better quality than those now available are needed. And, as an outgrowth of World War II, optical glasses transmitting the ultraviolet and the infrared are much desired. So it seems safe to say that many of the chemical elements not formerly used commercially in optical glass will become important constituents of it in the future. Especially will this be true as far as infrared transmitting glasses are concerned. To produce glasses having satisfactory transmissions beyond about 4.5 microns, glass-formers other than silica, boric oxide and phosphoric anhydride should be investigated. Hence, there remains much research work to satisfy the enthusiastic investigator for years.

Grateful acknowledgment is hereby made to the many past and present members of the Glass Section, Mineral Products Division, National Bureau of Standards, whose collaboration in the development of control and produc-


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In 1943, on Jan. 24th, President Roosevelt and Prime Minister Winston Churchill conferred in Casablanca on invasion plans . . . and on May 11, held another meeting in Washington . . . Nov. 20, Roosevelt, Churchill and Chiang Kai-Shek began a five day conference in Cairo . . . on Dec. 1, Roosevelt, Churchill and Stalin conferred at Tehran. On Dec. 24, General Eisenhower was appointed Supreme Commander of Anglo-American invasion forces.

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tion methods was responsible for the success of the work on optical glass. This work was under the direction of A. N. Finn, Chief of the Glass Section, until the time of his death in 1942. The contributions of W. W. Coffeen, C. C. Diller, C. A. Faick, A. C. Francisco, R. A. Heindl, D. Hubbard, F. R. Matson, L. H. Maxwell, C. B. Riecks, L. Shartsis, A. Q. Tool, O. F. Valentine, A. E. Williams and J. C. Young also deserve special mention.

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• The Board of Directors of the American Window Glass Company has announced the election of D. M. Veon, Jr., as Controller.

### THREE-YEAR EXPANSION PROGRAM UNDERWAY AT BROWN

A three-year program for expansion of development and production operations has been started by Brown Division of Minneapolis-Honeywell Regulator Company as the second step in its $2,500,000 physical expansion. The first part of the three-year program has resulted in the hiring of 40 newly graduated engineers.

The plan, according to Henry F. Dever, President of Brown Instrument Company, includes speedy indoctrination of the new engineers who are being assigned to various engineering departments. It means an immediate expansion of the company's development engineering by 30 per cent and by 10 per cent in application, industrial and general engineering.

After initial indoctrination in company departmental operations, each graduate is being given a course in development, manufacture and application of industrial measuring, indicating and controlling instruments.

### L-O-F PURCHASES SHREVEPORT PROPERTY

Libbey-Owens-Ford Glass Company has announced the purchase of a 10-acre tract of land adjacent to its present glass factory in Shreveport, which will be used for future expansion.

John H. Goodwillie, Manager of the company's Shreveport plant, said that definite plans were not yet formulated and that the company has made no detailed announcement regarding the eventual use of the land. The recent addition increases the firm's holdings to 77 acres.


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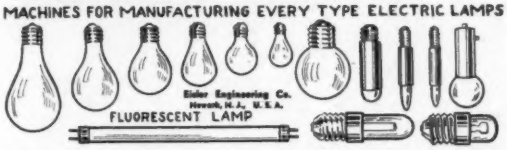


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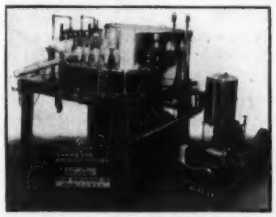

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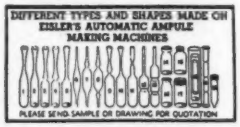
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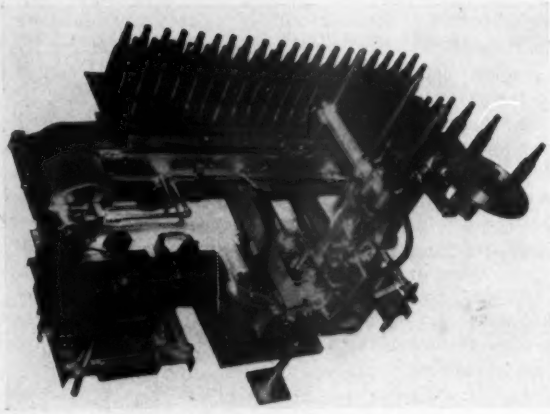

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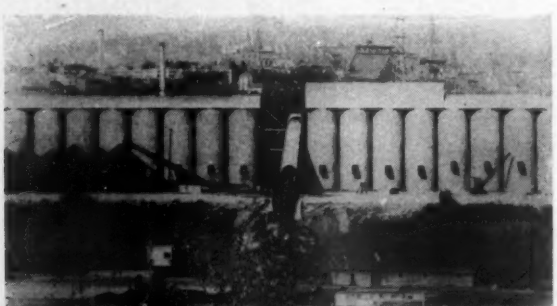

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**Coal from barges is conveyed into these Neff & Fry Super-Concrete Stave Silos which have 4,000 tons storage capacity. Average hourly delivery via truck is 300 tons. From the gates in the four bins at the right, two gondolas are simultaneously loaded in five minutes. The Hatfield Campbell Creek Coal Co., Cincinnati, operates the plant.**

**This is typical of our many large installations of storage bins for the economical handling of flowable bulk materials—coal, chemicals, cinders, lime, sand, grain, seeds, sawdust, ore, water, etc., etc.**

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**NEFF & FRY STORAGE BINS**

## DIAMOND ALKALI APPOINTMENTS

Two key appointments within the sales organization of Diamond Alkali Company have been announced by Fred W. Fraley, Sales Vice President.

J. C. McKenna, for the past six months Product Manager of chromium chemical sales for the company, has been named Product Manager of Alkali Sales. He succeeds J. D. Mattern retired.

**J. C. McKenna**

Succeeding Mr. McKenna is Charles E. Grant, assistant to the president of the Martin Dennis Company since this manufacturer of chromium chemicals was acquired by Diamond Alkali earlier this year.

In his new post, Mr. McKenna and Director of Sales W. H. McConnell will handle the increasing responsibility of marketing Diamond's greatly expanded output of alkali chemicals. Since 1938, the company has stepped up soda ash production by approximately 45 per cent, Mr. Fraley stated.

## RECENT RUSSIAN BOOKS ON GLASS

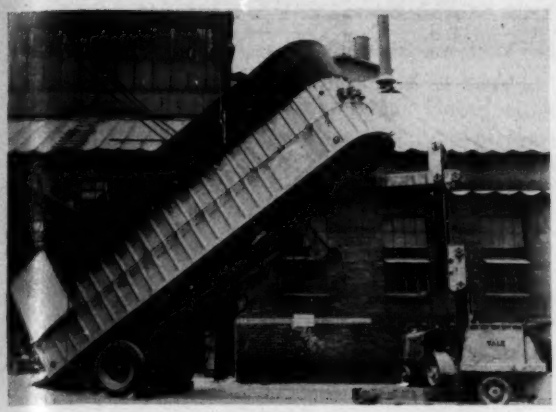
Reviews of the following books, among others, were published in *Stekol'naya i Keramicheskaya Promyshlennost* (Glass and Ceramic Industry) in 1947.

"Use of colloidal graphite as lubricant in glass industry," by O. K. Botvinkin and V. T. Marinina. "Gizlegprom" (State Publishing House of the Consumer Industry). Moscow and Leningrad, 1946. 72 p., illustrated. Price 4 rub. The book originated from the All-Union Scientific Research Institute of Glass Industry. It deals with the preparation of lubricants on the base of colloidal graphite, the use of these lubricants in glass industry, their laboratory testing and with the organization of lubrication on plant scale. An instruction for lubricating the molds for glass follows in an appendix. 72 literature references are given.

"Manufacture of laminated glass," by A. Kh. Ashkinazi, with preface by A. A. Litvakovskii. "Promstroiizdat" (Publishers for the Building Industry). Moscow. 1946. 76 p., illustrated. Price 4 rub. 50 kop. The book gives information on all phases of the manufacture of laminated glass ("triplex") including the raw materials and their storage, the fabrication procedure, the usual defects and their elimination, the testing of the finished product, the making-up of the balance sheet and the industrial hazards involved.

"Methods of raising the velocity of withdrawing glass sheets," by S. I. Korolev and T. D. Koroleva, with preface by I. I. Kitaigorodskii "Promstroiizdat" (Publishers for the Building Industry) Moscow. 1947. 31 p. Price 2 rub. Experiences of a glass plant in Riga concerning high production velocities on Fourcault machines are described.

"Sodium silicates in glass making," by N. P. Krasnikov. "Stroiizdat" (Publishers for Building). Moscow. 1946. 60 p. Price 3 rub. Use of sodium silicates in glass making is discussed. 70 literature references are listed.



*Courtesy of The Yale & Towne Mfg. Co.*

### TRAILER TRUCKS UPENDED FOR SPEEDIEST UNLOADING

As an aid in unloading street-truck loads of bulk commodities at the Ball Brothers Company plant in Muncie, Indiana, a 6,000-pound capacity high-lift industrial platform truck converts the large trailer to a dump-truck, as shown above.

The load illustrated happens to be silica sand, a raw material which lends itself well to this type of handling. Transporting the sand in large vans makes it possible to haul larger loads than could be transported by dump truck. Upending the trailers by telescopic platform truck saves time and energy which would normally be spent in shoveling out the trailer. The trailer is dumped merely by blocking the rear wheels and tilting the front end upwards with the Yale industrial truck.

### LACLEDE-CHRISTY STARTS PRODUCTION AT CALIFORNIA PLANT

Don N. Watkins, President of Laclede-Christy Company, has announced that production of glass industry refractories has been started at the company's new Warm Springs, California, plant.

Construction of this unit was started May 1, 1948. It is a part of an ultra-modern and complete fire brick plant to be built on the 22 acres purchased by the company.

### DU PONT LISTS PATENTS

E. I. du Pont de Nemours & Company, Inc., has announced that it is listing a number of its patents on the Patent Register of the U. S. Patent Office as available for licensing.

The company announced that 4,260 patents, which are about two-thirds of the patents it owns and which cover many phases of its diversified operations, have been submitted. The first official listing of the patents is expected to appear in an early issue of the Patent Office Gazette.

• A streamlined and modern course in ceramics is being offered in the Ceramic Studios of the American Handicrafts Company. The courses will endeavor to simplify the making of articles out of clay. Tools, equipment, supplies and a complete firing service will be made available to the students.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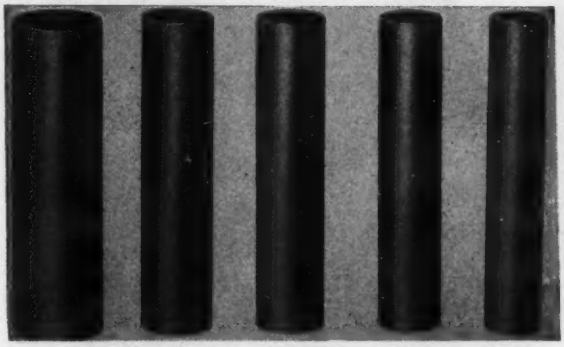

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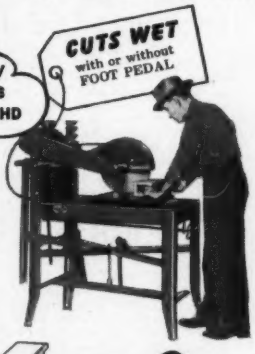


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STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912, AND MARCH 3, 1933

THE GLASS INDUSTRY, published monthly at 55 West 42nd Street, New York 18, N. Y., for October 1, 1948, State of New York, County of New York, ss:

Before me, a Notary Public in and for the State and County aforesaid, personally appeared John T. Ogden, who, having been duly sworn, according to law, deposes and says that he is the Publisher of THE GLASS INDUSTRY and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: John T. Ogden, publisher, 55 West 42nd Street, New York 18, N. Y. Cyril B. Delgado, editor, 55 West 42nd Street, New York 18, N. Y. Managing editor, none. Cyril B. Delgado, business manager, 55 West 42nd Street, New York 18, N. Y.

2. That the owners are: Ogden Publishing Company, 55 West 42nd Street, New York 18, N. Y. John T. Ogden, 55 West 42nd Street, New York 18, N. Y. Katherine Waller Ogden, 55 West 42nd Street, New York 18, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of the total amount of bonds, mortgages, or other securites are: None.

4. That the two paragraphs next above giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has not reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(Signed)
JOHN T. OGDEN, *Publisher.*

Sworn to and subscribed before me this 9th day of September, 1948.

Harry Wolf
Notary Public in the State of New York
Kings County Clerk's No. 545
New York County Clk's No. 965
Commission Expires March 30, 1949

## THE GLASS GLOSSARY . . .

(*Continued from page* 558)

and more or less fanciful and involved words that language grows; and it may be that our language may be made richer by acquiring these words that are now the sole possession of the relatively few who work with glass.

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## BORIC OXIDE—ITS CHEMISTRY AND ROLE IN GLASS TECHNOLOGY . . .

(*Continued from page* 561)

fuel situation will no doubt make boric oxide more popular because it allows the glass melter to work at a somewhat lower temperature without sacrificing other qualities. Closely connected with melting and fining are the viscosity and the temperature coefficient of viscosity. In this respect boric oxide may gain importance with the general trend of increasing the speed of automatic production of glass ware.

The improvement of the chemical resistivity of glasses by $B_2O_3$ is established beyond doubt, but its importance varies with the glass composition used, so that no general statement can be made. Of greater interest is its role in avoiding devitrification for those glasses and in those operations where crystallization is a major source of defects.

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## A.C.S. SECTION SPONSORS GLASS DIVISION

On July 8, 1948, a Glass Division was organized under the sponsorship of the Southern California Section of the American Ceramic Society. Meetings are planned every three months.

The officers who were selected for the year are: Chairman, Wolfram Seitz, Glass Containers, Inc.; Vice Chairman, George Loeffert of Latchford-Marble Glass Company; and Secretary, E. K. Pryor, The Pryor-Giggey Company.

The first meeting of the Division will be held during the early part of October. The speaker will be A. K. Lyle of Hartford-Empire Company, whose subject will be "The Relationship of Glass Technology to Furnace and Machine Operations."

## QUALITY CONTROL CONFERENCE SCHEDULED FOR NOVEMBER

The nine midwest sections of the American Society for Quality Control will hold their Third Midwest Quality Control Conference at the Sherman Hotel in Chicago on November 4 and 5, 1948. The Conference is again being sponsored by the Chicago Association of Commerce and Industry.

Under the general chairmanship of James M. Ballowe of Aldens, Inc., the full Planning Committee has been meeting regularly for a year and a well-rounded program has evolved. In addition, the Conference will feature many exhibits where the latest devices for measurement and control will be demonstrated.

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### DEDICATED PATENTS

It has been reported by the U. S. Patent Office that the following patents and application held by Glass Science, Inc., have been dedicated to the public of the United States as recorded in the U. S. Patent Office. The patents are:

Pat. 2,428,600. Method of Staining Glass With Copper Halide Vapor. Patented Oct. 7, 1947. Ordinary soda lime glass (such as that used for window panes or bottles) may be successfully colored when volatile copper salts (such as cuprous chloride) are caused to react with the glass heated at temperatures ranging from 500° to 800° C., for varying lengths of time. If a high temperature and salt concentration is used, the glass will be coated with a reflecting metallic surface, or, if low concentrations are used, colors ranging from faint pink to deep red may be obtained, depending on the length of time the glass is subjected to treatment. The process may be advantageously used for treating individual glass articles for decorative and other purposes. The mirrored surfaces obtained cannot be dissolved by nitric acid. Group 32—39.

Pat. 2,430,520. Deposition of Metal on Glass From Metal Formates. Patented Nov. 11, 1947. This patent is somewhat similar to Pat. 2,428,600 except that the process is performed under vacuum. Metallo-organic compounds such as copper formate, or acetate, or the acetylacetonates of copper, nickel, or platinum are suitable. The glass article being coated is heated (350°-450° C.), and vaporized metal deposited on the glass surface produces a mirror, the thickness varying with the length of the process. Group 32—39.


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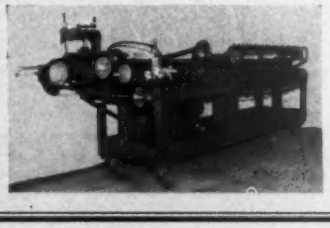
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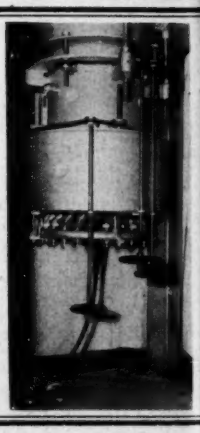

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